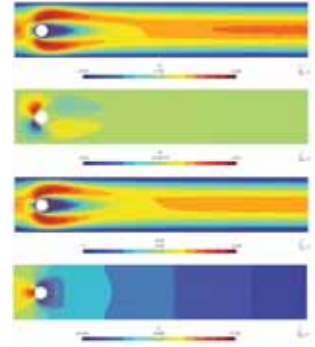
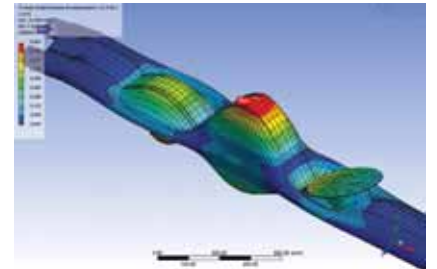


Assessment of Optimization Algorithms for Winglet Design
 Design optimization of 3D winglets leads to performance improvement of a Piaggio Aero business jet

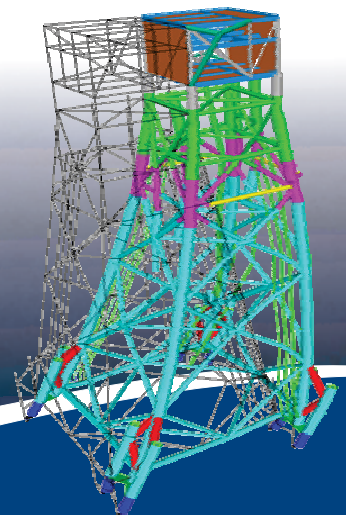
Scilab Finite Element Solver for stationary and incompressible Navier-Stokes equations



L'ingegner Paci testimonial del successo delle tecnologie CAE in Perini Navi



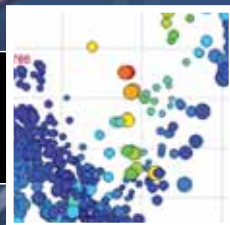
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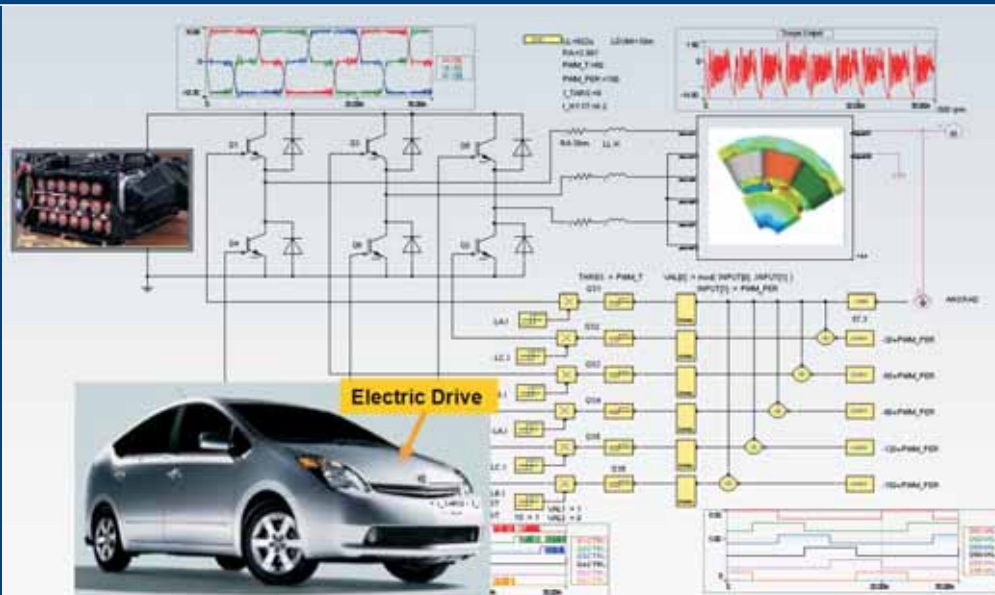


Optimization of Child Restraint System with Load Limiter and Airbag using Child FE Human Model in Frontal Crash



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The 1st edition of the Newsletter in the year 2010 features a diversity of technologies, applications and expertise in CAE.

CAE and simulation are our business and our passion.

In this issue, we feature the CAE work of world-known enterprises and brands, such as Lamborghini Automobili and Piaggio Aero. Franco Tosi, a leader in the production of power steam and hydraulic turbines, presents a transient CFD analysis for the evaluation of the performance of a Pelton Turbine. We bring to our readers the expertise of esteemed academic institutions: University of Rome, University of Magdeburg, Germany, Doshisha University, Japan, just to name a few which are highlighted on the following pages.

After all, it is the knowledge about CAE and simulation, continuously transferred from academia to research onto industry that leads and will lead to technological advancements in product design and development in this century.

Knowledge and experiences shape our personalities, they guide us through and to the next phases in our lives and careers, they fuel our inspiration, creativity and our striving for progress and innovation.

It is in this context that we present IMS2020, an EU Project that reveals research and development challenges for the manufacturing industries in the upcoming decade.

Talking about software and the next generation of simulation engineers, we inform our readers about Scilab, a free open source software. Scilab has, over the years, contributed to numerous projects linked to simulation. EnginSoft France supports the Scilab Consortium as a member from industry with a strong background in R&D and educational initiatives for CAE.

Our Software News feature the ANSYS Workbench, ANSYS Composite PrePost and Electrostatic environments, Forge from Transvalor, Third Wave Systems AdvantEdge FEM version 5.5 and Production Module 5.7 and the latest powerful release of modeFRONTIER: 4.2



Ing. Stefano Odorizzi
EnginSoft CEO and President

We are delighted to present CDAJ, CD-adapco JAPAN Co.,LTD, the engineering solutions provider that launched modeFRONTIER on the Japanese market in 2001. Today, modeFRONTIER is one of the most successful software for optimization in Japan.

The corporate news report about our cooperation with Tecnomare, a renowned engineering company of ENI Group. The multidisciplinary expertise offered by EnginSoft, ranging from structural analysis to thermal fluid-dynamic and process simulations, convinced these global players in the Oil&Gas sector to intensify the work with our engineering team.

We spoke to Matteo Paci, design engineer at Perini Navi, about the successful use of CAE in the shipbuilding industry. Currently, Perini Navi is the only shipyard in the world to design, develop and build its own sailing yachts.

This edition also includes news on research and technology transfer, ongoing research projects, our worldwide Event Calendar and more...

To anyone interested in optimization, we recommend to join the International modeFRONTIER Users' Meeting 2010, 27-28 May in Trieste, to hear about the latest advancements of the technology.

Believe in Simulation – Simulate the World is the motto of the 2010 International EnginSoft Conference. From 21-22 October, in Montechiari, Brescia – Italy, many of the world's leading simulation experts will come together and contribute to an outstanding conference program. The major event for CAE and VP Virtual Prototyping will take place concurrently with the ANSYS Italian Conference and feature one of the largest exhibitions dedicated to computer simulation in Europe. The EnginSoft Conference is perceived by many as an excellent platform for interaction, networking and innovation.

Please stay tuned to www.caeconference.com for the Call for Papers and meet us in Montechiari to speak about the future of simulation and CAE.

Stefano Odorizzi
Editor in chief

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PRINTING

Grafiche Dal Piaz - Trento

The EnginSoft NEWSLETTER is a quarterly magazine published by EnginSoft SpA

Assessment of Optimization Algorithms for Winglet Design

Design optimization of 3D winglets leads to performance improvement of a Piaggio Aero business jet

A numerical optimization procedure has been set up coupling a parametric CAD model, a structured mesh generator and a Navier-Stokes solver. The procedure has been applied to the design and optimization of 3D winglets of a business jet aircraft. Significant effort has been applied to the development of an efficient CAD model parameterization. Several preliminary optimization cycles have been carried out with the aim to define the opportune optimization strategy in terms of variable selection, constraints and target definitions. The final single objective optimization described in this article led to the successful design of a device and provided significant performance improvements, even with a strong constraint in the wing root bending moment. In a second phase, an optimization algorithm assessment has been performed on a typical 2D test case. The performances of SIMPLEX, genetic based and other advanced algorithms have been evaluated and compared in terms of quality of the optimum solution and convergence properties.

List of symbols

- C_d : 2D drag coefficient
- C_{d3} : 3D drag coefficient
- C_l : 2D lift coefficient
- C_{l3} : 3D lift coefficient
- C_{Mx} : moment coefficient around X axis.
- C_{Mx0} : constraint limit of the moment coefficient around X axis.
- M: Mach number
- Obj.fn: objective function
- Re: Reynolds number
- α : angle of attack

Introduction

A design problem can be regarded as a creative process of searching for the "optimal" compromise solution within an iterative loop. The more complex and thorough the designer's knowledge and experiences are, the higher the design quality will be. For this

reason, considerable research has been done on how human designers work and in developing automatic decision making algorithms able to speed up such design processes [1]. Thanks to the improved reliability of modern numerical analysis tools and the exponential growth of computational power in recent years, numerical optimization methods are in great demand in nearly all industrial engineering areas. Today, numerical optimization is a leading design methodology in the aerospace sector, in both the industrial and research fields, and a key factor for competitiveness.

Optimization is the process of finding a set of design parameters, known as design variables, $x = \{x_1; x_2; \dots; x_n\}$, that can be defined as optimal because they minimize or maximize one function $f(x)$, called objective function, or a set of functions (mono-objective or multi-objective optimization). If the objective function (functions) has (have) to verify some constraints, the optimization is defined as constrained optimization.

The aim of this work is to describe an industrial application of an optimization process and to investigate the performance of several algorithms for a mono and multi-objective case.

The optimization of winglets suitable for a business aviation class aircraft is discussed in the first part of the article. In the second part, the results of the assessment of several optimization algorithms applied to the aerodynamic design of a 2D airfoil are detailed. In a mono-objective optimization

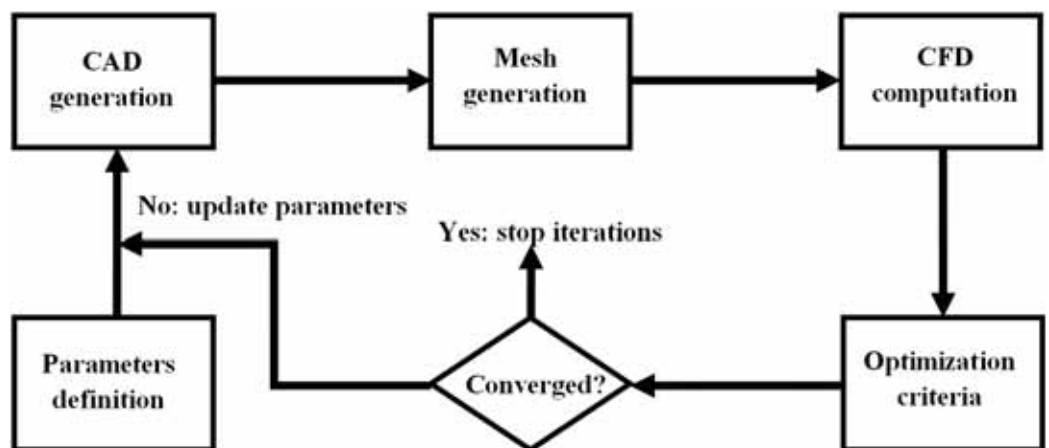


Fig. 1 - Flow chart of the optimization procedure.



case, the SIMPLEX method developed by Nelder & Mead is compared to the performances of a Genetic Algorithm using a smart elitism operator. In a multi-objective optimization, four types of Genetic Algorithms and three Advanced Models are compared.

Part 1: Winglets optimization

The lift of an aircraft is generated by the pressure difference between the upper and the lower surface of the wing. The pressure difference induces a flow from the lower towards the upper surface around the leading edge and the wing tip [2]. This flow regime generates the so-called “tip vortices” which produce a down-wash effect. The down-wash effect is responsible for the local angle of the attach variation, and consequently for an additional drag component called “induced drag”. The induced drag is linked to the mechanism for lift production, its value is related to the strength of the tip vortex. Winglets are wing tip devices whose objective is to recover part of the tip vortex energy in order to produce a force with a component in the forward direction. The effect is to generate some extra lift and to reduce the induced drag which decreases the strength of the vortex (similar effect as to increase the wing span).

The installation of well-designed winglets can improve the performance of an aircraft, however, the following aspects are critical:

- 1) The design must be strongly customized to each new configuration;
- 2) Winglets introduce additional weight;
- 3) They increase the wing root bending moment;
- 4) Efficiency is proportional to the lift coefficient;
- 5) They can alter the aerodynamics in critical regions (ailerons);
- 6) Winglets are expensive.

In this work, winglets for a business class aircraft have been designed and optimized in cruising speed conditions with the following constraints:

- The wing root bending moment increase should not be higher than 5%;
- No degradation of the wing characteristics (stall path and shock generation) is allowed.

The optimization procedure is schematized in figure 1. The objective function to minimize is the following:

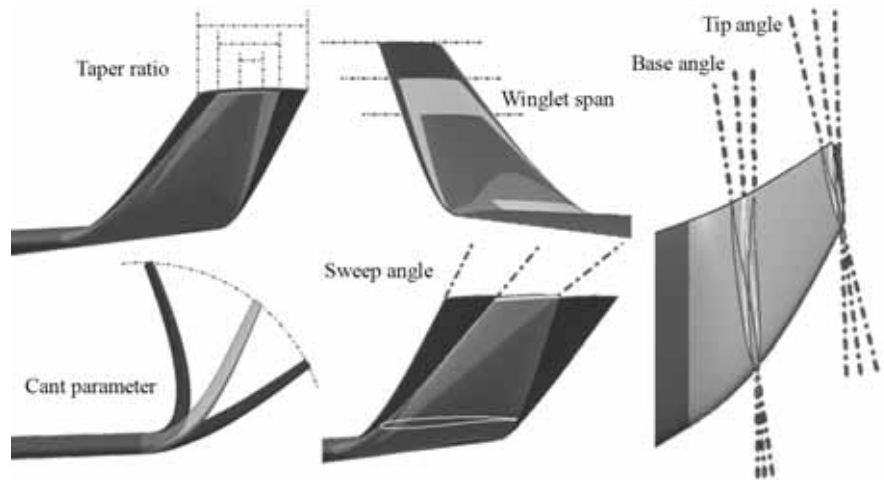


Fig.2 - Winglets CAD model and design parameters.

$$C_{M_{00}} \leq C_{M_0} \Rightarrow \text{Objfn} = -\frac{C_l}{C_D}$$

$$C_{M_{00}} > C_{M_0} \Rightarrow \text{Objfn} = -\frac{C_l}{C_D} [1 - 20(C_{M_{00}} - C_{M_0})^{0.5}]$$

The constraint is introduced into the optimization function when the wing bending moment exceeds the limit value of $C_{M_{00}}$ which is the root bending moment of the wing without winglets increased by 5%.

Particular effort has been devoted to the development of an efficient and robust parametric CAD model. The objective was to generate a model able to reproduce the widest range of possible geometries with a minimum of parameters and to avoid the possibility to degenerate an unfeasible geometry under any parameter combination. The chosen topology is a blended winglet (figure 2) whose geometry is controlled by four parameters for the platform and two for the angle of incidence, listed as follows:

- 1) Cant parameter;
- 2) Taper ratio;

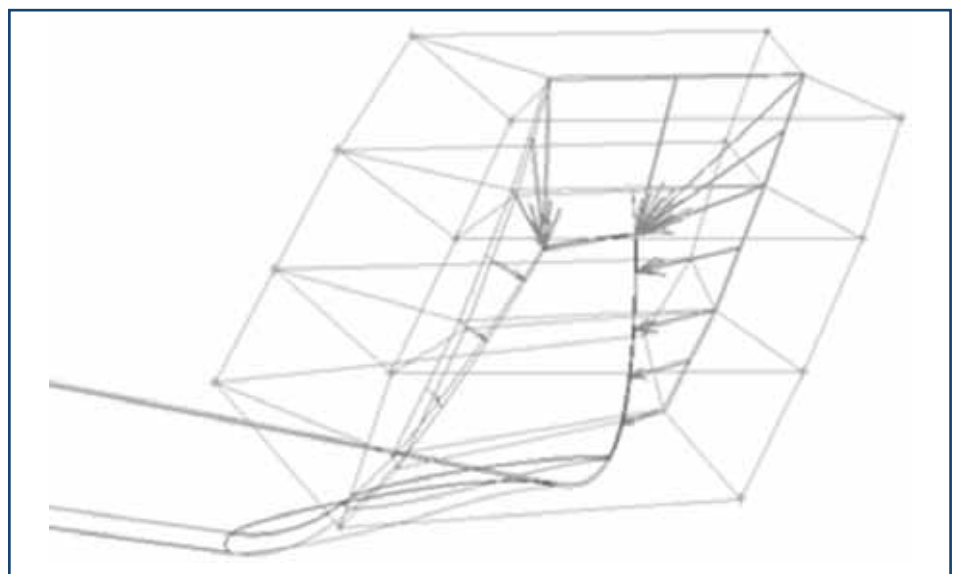


Fig.3 - Detail of mesh blocking topology



- 3) Winglet span;
- 4) Sweep angle;
- 5) Base angle;
- 6) Tip angle.

The airfoils at the tip and base section are also parameterized by a set of control points. However, preliminary optimization cycles showed that, in absence of shock or separation, their influence has a negligible effect on the optimization function.

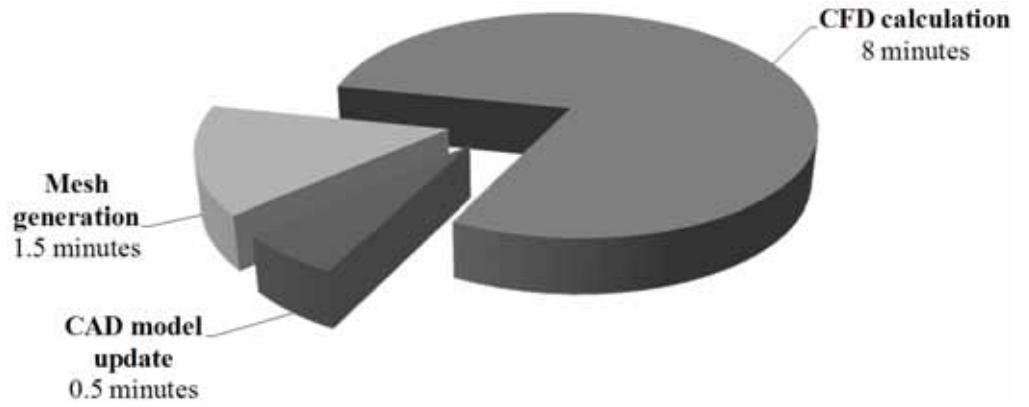


Fig.4 - elapsed time per evaluation.

Therefore, the airfoils have been designed separately and frozen in the final optimization process we describe here.

The computational domain is automatically generated by a user defined script. It guides the code in the updating process of the geometry from the new CAD model. It projects the vertexes, the edges and the faces of a previous defined blocking topology to the updated geometric entities (figure 3); it also re-computes the structured hexahedral grid. Finally, it exports the new mesh in a format compatible with the CFD solver to be used. The grid has 2 millions of elements and the far-field is 30 chords.

The next step is the RANS computation on the new design. The Spalart-Allmaras turbulence model [3] has been used. In order to speed up the iteration, some simplifications have been adopted. The wall of the fuselage and the engine nacelle are considered inviscid. Wall function has been applied to the wing and winglets. The boundary conditions at the engine inlet (static pressure) and outlet (total pressure and temperature) are derived from the engine data.

The total elapsed time for one evaluation using 64 cpu on a Linux cluster, restarting the CFD run from the solution of the previous iteration, is about 10 minutes, 8 for the analysis

and 2 for the geometry update and mesh generation (figure 4).

The optimization algorithm used is the SIMPLEX. The convergence of the solution was obtained after around 70 iterations. Figure 5 and 6 show the convergence histories of the six variables and the objective function. The aerodynamic efficiency was improved by 5% maintaining the wing root bending moment increase at 5.4%. The drag reduction of the completed aircraft was estimated at around 3% of the trimmed configuration.

The aim of the second part of this work is to assess some of the optimization algorithms of the modeFRONTIER optimization environment. The actual test case is the optimization of an airfoil in transonic conditions. The geometry is described by 28 design variables, which define the control points of a Bézier polynomial [4], [5]. The computational grid around the airfoil is automatically generated by a batch command. A coupled Euler/Boundary Layer 2D solver is used to evaluate the aerodynamic performance of the airfoil. Each evaluation requires about 20 seconds. Several mono and multi-objective optimizations have been performed.

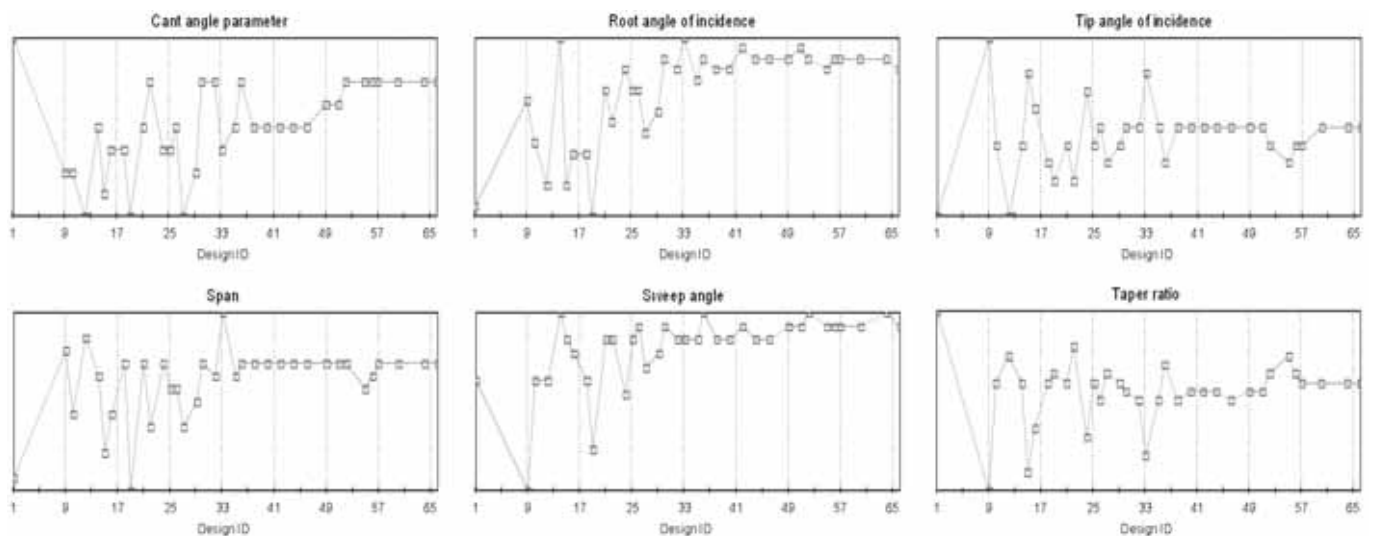


Fig.5 - Variables histories.



- 1) Mono-objective optimization using:
 - a. SIMPLEX algorithm of Nelder & Mead (1965), with continuous and discrete variables;
 - b. MOGA-II, Genetic Algorithm with a smart elitism operator [6];
- 2) Multi-objective optimization using:
 - a. Genetic Algorithms:
 - i. MOGA-II;
 - ii. ARMOGA, based on the design range adaption;
 - iii. FMOGA-II, which uses the response surface methodology;
 - iv. NSGA-II, based on the Non-Dominated Sorting G.A. [7];
 - b. Advanced Models:
 - i. MOGT, based on the game theory (J.F. Nash, 1951), coupled with MOGA-II;
 - ii. MOSA, based on Simulating Annealing [8];
 - iii. MOPSO, based on Particle Swarm Optimization [9].

Mono-objective optimization

The objective function has been defined by weighting the drag coefficient in the following three design conditions.

- 1) $\alpha_1 = 2.8^\circ, \quad M_1 = 0.734, \quad Re_1 = 6.5 \cdot 10^6;$
- 2) $\alpha_2 = 2.8^\circ, \quad M_2 = 0.754, \quad Re_2 = 6.2 \cdot 10^6;$
- 3) $\alpha_3 = 1.8^\circ, \quad M_3 = 0.68, \quad Re_3 = 5.7 \cdot 10^6;$

$$Objfn = 2 \cdot C_d(\alpha_1, M_1, Re_1) + C_d(\alpha_2, M_2, Re_2) + C_d(\alpha_3, M_3, Re_3)$$

The reason for including more than one design point in very close flight conditions is to avoid the optimization process to converge to a shockless airfoil.

The starting solution was the RAE 2822 supercritical airfoil. The lift coefficient was always constrained while the minimum thickness constraint has been tested as an option leading to different solutions. Figure 7 details the convergence history of the optimizations without (7a) and

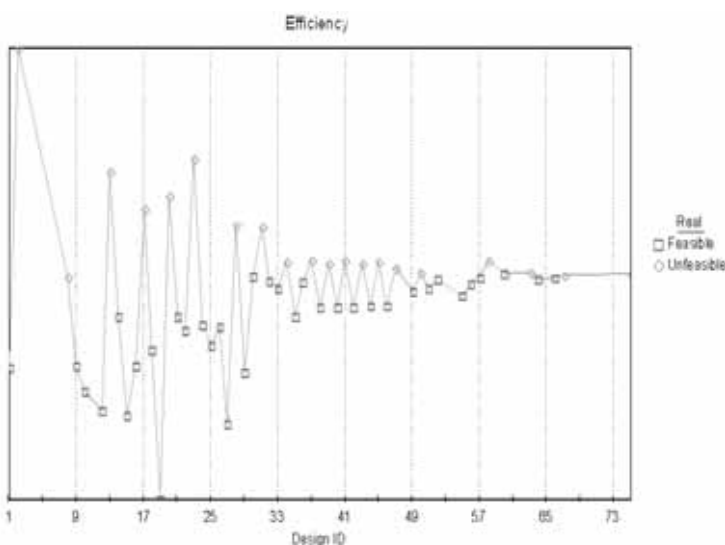


Fig.6 - Objective function convergence history.

with (7b) the imposition of the minimum thickness constraint.

Without the thickness constraint, the MOGA-II led to the best solution, despite the fact that it required about 30% more evaluations than the SIMPLEX. The SIMPLEX algorithm with discrete variables was the fastest to converge, but the optimum was not as good.

If the minimum thickness is a constraint, the SIMPLEX method proved to be more efficient than the MOGA-II, either by using discrete variables or continuous variables.

Multi-objective optimization

Two typical conflicting design targets have been selected to evaluate the multi-objective optimization algorithms:

- 1) Minimization of the drag coefficient in high-speed conditions:
 $C_d=0.8, \quad M=0.734, \quad Re=6.5 \cdot 10^6$
- 2) Reduction of the nose pressure peak coefficient in low-speed conditions at high incidence:
 $\alpha=10^\circ, \quad M=0.2, \quad Re=8 \cdot 10^6$

The minimum thickness of the airfoil was imposed as constraint. The Pareto fronts obtained by the several algorithms evaluated are compared in figure 8. In the same figure, a bar graph comparing the number of evaluations required to converge is reported.

All the models provided similar Pareto fronts. The ARMOGA model seems to be a better compromise between solution and convergence velocity. The fastest algorithm is the hybrid MOGT coupled with MOGA-II, but in the present case, it did not properly investigate the entire solution space.

Conclusions

An efficient and robust optimization procedure has been set up coupling a parametric CAD model, a structured mesh generator and a Navier-Stokes solver. Winglets suitable for a business class aircraft have been designed and optimized in a complete aircraft configuration, including engines in flight. A single objective optimization using the SIMPLEX algorithm has been described. A drag reduction of 3% for the trimmed aircraft with the designed winglets installed has been estimated. In order to investigate the performance of other optimization configurations, an assessment of several algorithms applied to the mono and multi-objective optimization of a 2D transonic airfoil has been carried out. The performances of SIMPLEX, genetic based and other advanced algorithms have been evaluated and compared. In the unconstrained optimization, the SIMPLEX algorithm converged faster than the MOGA-II which, however, found a better solution exploring a wider range of variable combinations. The MOGA-II proved to suffer from the



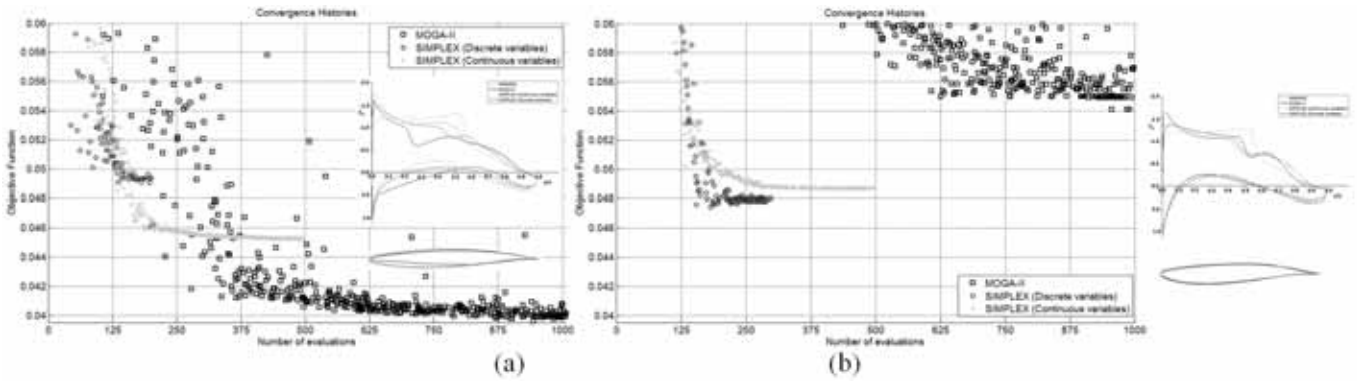


Fig.7 - Convergence histories, optimized airfoils and respective pressure coefficients of the mono-objective optimizations performed without (a) and with (b) the minimum thickness constraint imposition.

thickness constraints imposition. In the multi-objective optimization, the several algorithms tested obtained very similar Pareto fronts. The ARMOGA seems to provide a better compromise between solution and convergence velocity. The hybrid MOGT coupled with MOGA-II is very fast but it failed to investigate the entire solutions space.

Future work

A detailed parametric study of algorithm performances requires huge efforts which could not be made in the frame of this work. Each algorithm might deliver a better performance than described in this article, if we tune it more accurately and orient it better to the specific case. Further activities are suggested to complete this investigation, in particular:

- to evaluate the efficiency of the algorithms with a deeper parametric investigation,
- to evaluate the sensitivity to the initial solution/population and select one or more test cases in order to be able to generalize the parametric investigation.

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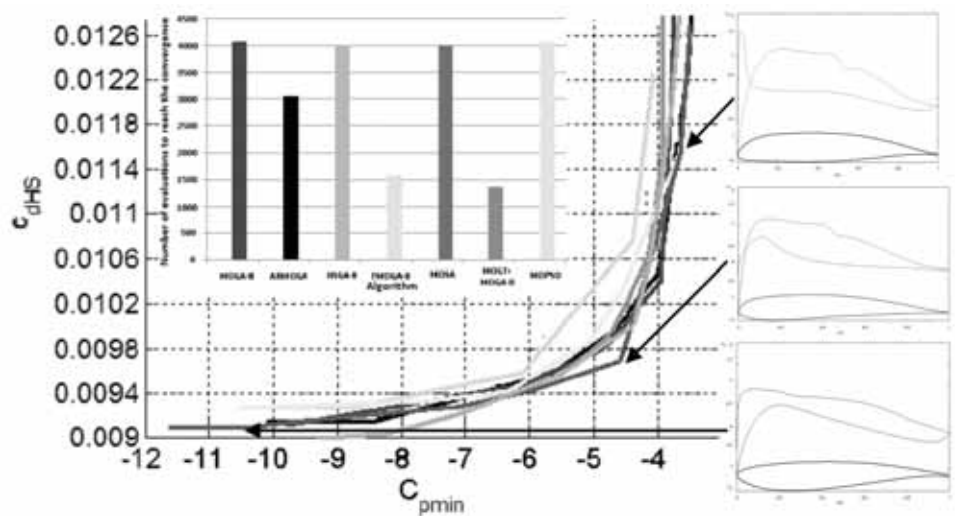


Fig. 8 - Solutions comparison of the multi-objective optimizations.



Transient CFD Analysis of a Pelton Turbine

Franco Tosi S.p.A. successfully employs ANSYS to evaluate the performances of a full scale Pelton Turbine



Franco Tosi S.p.A. is a leader in the Production of Power Steam and Hydraulic Turbines. In this work, we present the evaluation of the performances of a Pelton turbine. Particular emphasis has been placed on the flow behavior towards the buckets of the turbine wheel. Furthermore, water-jet interactions, cavitation phenomena, fluid recirculations and idle losses will be investigated.

The geometry processing as well as the domain discretization have been performed using ANSYS ICEMCFD while, for the CFD analyses, ANSYS CFX has been employed.

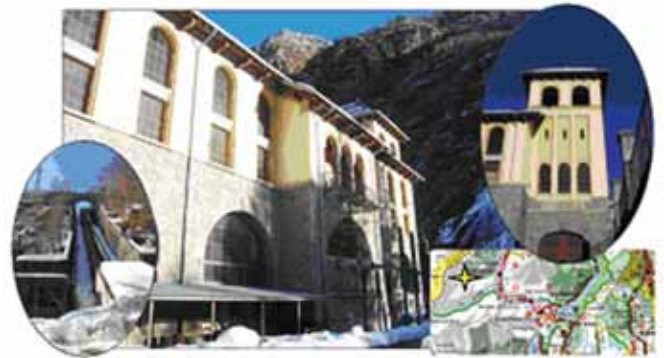


Fig. 1 - Rovesca hydropower plant

Franco Tosi Meccanica

Franco Tosi Meccanica S.p.A. (FTM) operates in the power generation industry since early 1900. The Italian company headquartered in Legnano (MI) is specialized in the design, manufacture, installation and start-up of medium to high power steam and hydraulic turbines ranging from 1 to 700 MW. Typical applications address power plants as well as civil and industrial cogeneration systems for both Italian and foreign markets. Furthermore, a wide range of services is performed on numerous FTM installations all over the world.

Pelton Turbines at a glance

In recent years, global warming and environmental issues have led to a continuous growth in demands for green energy supplies. Hydropower is certainly one of the major resources in green power generation. New markets, also in developing countries, demands linked to the repowering of plants, maintenance and reconditioning (especially in the Western markets), explain the growing efforts and investments in R&D for hydropower. The common goal is to provide more efficient and more reliable systems for the future.



Pelton turbines play a primary role in hydraulic machinery as they represent one of the most efficient types of water turbines. Invented by L.A. Pelton in the 1870s, they have been the subject of many studies focused on increasing performances in terms of mechanical efficiency and reliability.



Before the advent of computers, researchers mainly considered dynamic similarity laws and experimental tests although results were not always easy to obtain and to analyze. This was particularly true for the evaluation of the fluid dynamics of the turbine buckets due to their complex shape, 3D geometry and the multiphase and unsteady nature of the flow.

Nowadays, CAE, and more specifically CFD, offers researchers and engineers sound opportunities in the research and development for Pelton turbines. These state-of-the-art technologies allow engineers not only to evaluate the three dimensional fluid flow on the bucket, but also to quickly estimate the effects of modifications on the machine design by applying a what-if scenario approach.



Fig. 2 - The machine object of study

The Mathematical Model

A hydroelectric power plant represents a complex system. From a fluid-dynamic point of view it is not strictly confined to the generating station, but also comprises the penstocks, the tailrace and all the necessary devices required to control the flow, such as, for example, the control valves.

Even if the creation of a model that includes all these entities would be possible, such an approach would be inopportune, both in terms of domain size and model complexity.

In the present case, thanks to prior investigation carried out by FTM on the penstock ducts flow, the computational domain at the injectors



Fig. 3 - Turbine geometry with simplified statoric frame

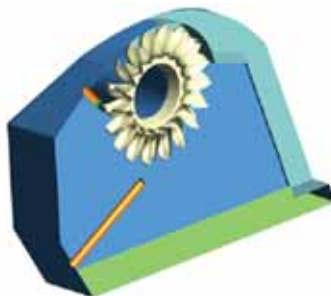


Fig. 4 - Half turbine model

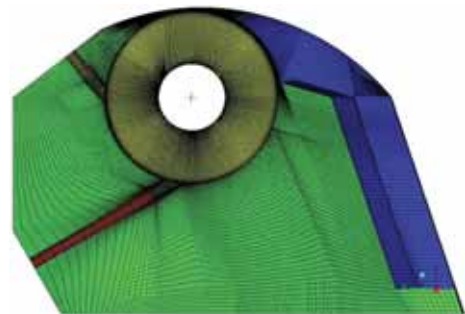


Fig. 5 - Statoric frame mesh

Rovesca Hydropower Plant

The Rovesca power plant is a recently restructured hydropower plant that is situated near Verbania in the Italian Alps. It is illustrated in Figure 1 and Figure 2.

In order to increase the plant's efficiency and reliability, the management asked FTM for support in reconditioning the systems with the primary objective to renew the Pelton turbine.

TURBINE RATING		
Flow Rate	[m ³ s ⁻¹]	239
Power	[MW]	15 589
Shaft speed	[rpm]	900
Head	[m]	727.5

Table 1: Turbine rating

The machine, a 2 injectors Pelton turbine whose rating is reported in Table 1, is based on a horizontal-axis and 18 buckets.

outlet sections could be reduced. The obtained domain geometry is shown in Figure 3.

We should note that the injectors are just modeled as voids in the fluid domain: the water inlets correspond to the jets' vena contracta cross-sections whose details are

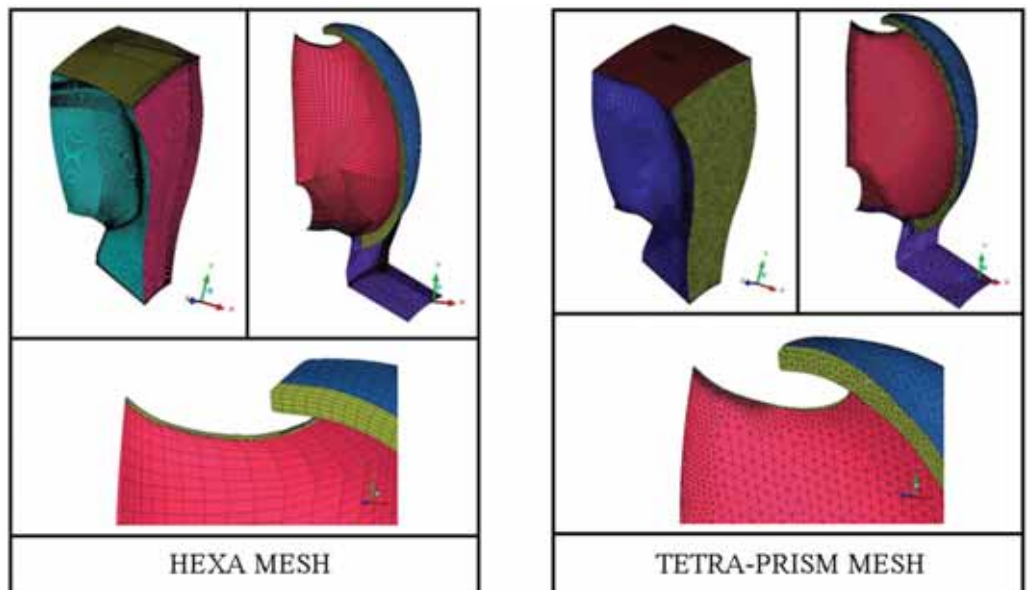


Fig. 6 - Rotoric single bucket mesh. Structured mesh (left), and unstructured tetra-prism mesh (right)



known thanks to the measurement. With the axial midplane symmetry of the machine, the model could be conveniently halved (Figure 4). No further computational domain reductions are possible due to the injectors angular displacement (80 deg). As a next step, the resulting domain has been decomposed into the statoric domain (Pelton wheel housing) and the rotor domain (Pelton wheel). Each domain has been discretized independently using ANSYS ICEM CFD. The stator frame discretization led to 1M cells, a full hexa mesh structure as shown in Figure 5.

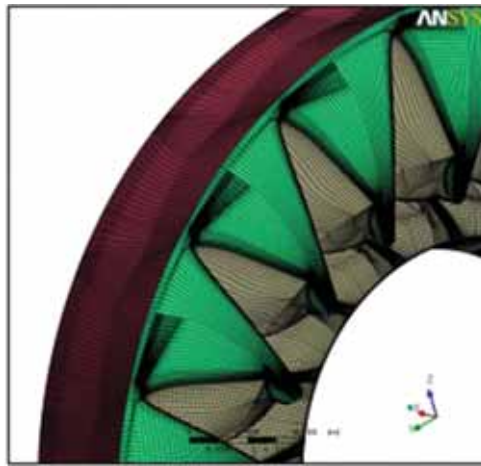


Fig. 7 - Fully hexahedral rotor frame assembly

Details of the obtained mesh are reported in Table 2.

The model setup in terms of boundary conditions is schematically illustrated in Figure 8. It consists of two fluid inlets, one for each injector, an opening outlet, to allow possible fluid recirculation occurring at the discharge section, a symmetry plane and, finally, two mesh interfaces in order to ensure fluid-dynamic continuity between stator and rotor frames.

The flow is multiphase consisting of liquid water and air. We assumed that both are incompressible and unmixable and therefore, a multiphase model has been adopted. With the purposes of the analysis in mind, a homogeneous mathematical treatment for both hydrodynamic and turbulence quantities has been chosen.

Furthermore, the adoption of an interface compression algorithm allowed a better resolution of the air/water interface.

The flow is also assumed to be fully turbulent, hence a suitable turbulence model is needed. In the present study, two different RANS models have

MESH	MESH TOPOLOGY				
	Tetrahedral Elements	Prismatic Elements	Hexahedral Elements	Total Elements	Total Nodes
Statoric Frame	-	-	935655	935655	995168
Rotoric Tetra Frame	6581283	2546136	-	10063074	-
Rotoric Hexa Frame	-	-	4864875	4864875	5172660

Table 2 - Mesh details

The rotor frame has been further reduced to a single bucket. Two different discretization approaches have been deployed: tetrahedral meshing (Octree algorithm with prismatic boundary layer extrusion) and structured hexahedral meshing (Figure 6 and Figure 7) which allowed mesh sensitivity studies.

During the entire discretization process, great care has been taken in treating the air/water free surface as well as the interfaces between the domains and the bucket boundary layers in order to ensure a proper resolution of the momentum transfer processes occurring in these regions. After all, they have a great impact on the wheel torque and, ultimately, on the efficiency of the machine.

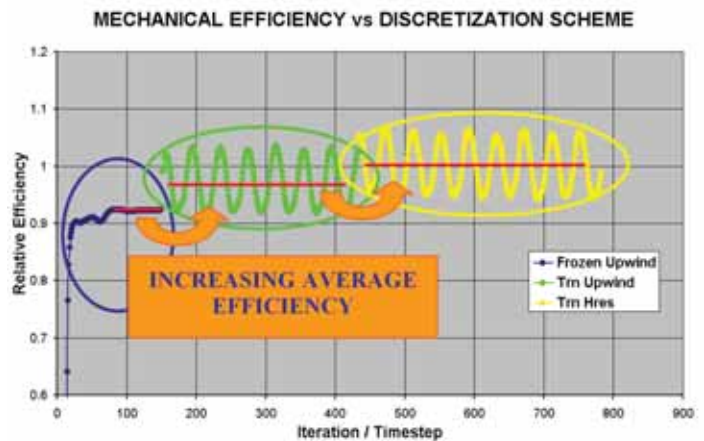


Fig. 9 - Correlation between average mechanical efficiency and numerical discretization scheme

been employed: k-ε and SST k-ω with an automatic boundary layer treatment based on the logarithmic wall law.

Steady state as well as transient analyses have been carried out. The former have been performed to initialize the flow, while the latter confirmed the actual machine performances including unsteady phenomena, and completely resolved all fluid jets-buckets interactions.

All the final transient runs adopted High Resolution schemes with second order spatial accuracy ensuring optimal gradients resolution.

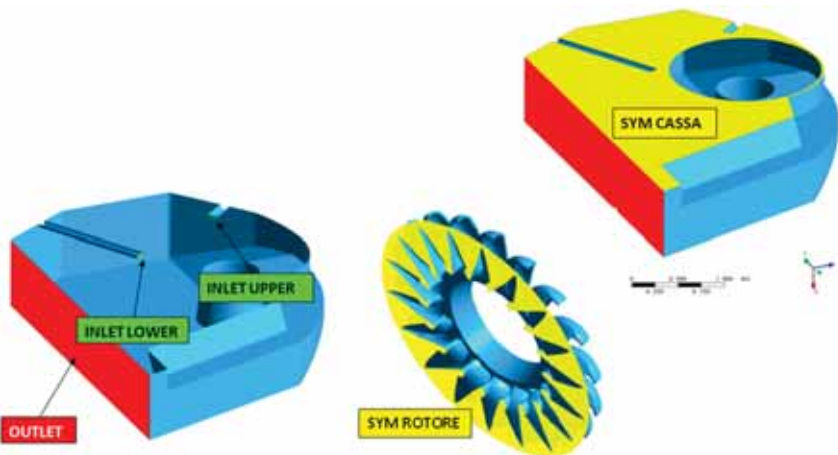


Fig. 8 - Boundary conditions



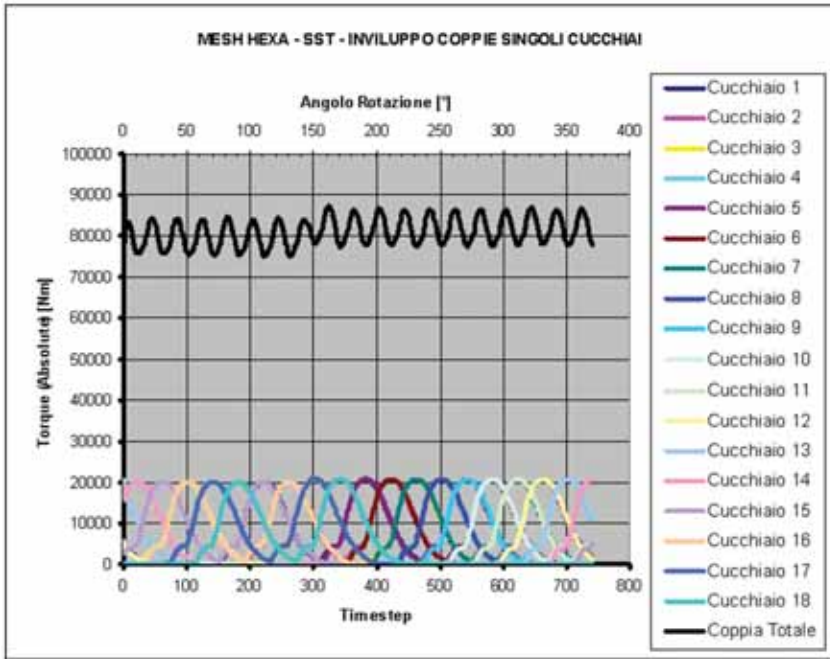


Fig. 10 - Buckets contributes to total hydraulic torque (black line)

efficiency than the previous one. Highest performances are reached by the fully hexahedral mesh.

Figure 10 shows the contribution of each single bucket to the total hydraulic torque (black line). Such contributions are of great interest to FTM's engineers as they can link them to the fluid dynamic state of the buckets (Figure 11). In this way, they can determine when the momentum transfer is not optimal and where to apply possible improvements to the bucket's shape.

The water path on the buckets is reported in Figure 15: thanks to the tools available in ANSYS CFD-Post, it was possible to evaluate the water layer thickness and distribution. Such details are important for Pelton designers, as they are extremely difficult to obtain experimentally but quite easy to retrieve with CFD. Another example of the

Solution

The simulations have been remotely run on the main EnginSoft HPC linux cluster. The cluster is powered by 324 cores based on a 64bit Intel Xeon cpu architecture and adopts the CentOS operating system. as well as Perceus, an enterprise management suite for HPC clusters deployment and management. Jobs submitted by users are handled by a Sun Grid Engine that manages queues in order to reach and maintain the highest possible availability and usability of the cluster's computational resources.

A powerful parallel data storage infrastructure, capable of continuous data flow of 400kB/s, completes the system. With more than 15 TB of total capacity it allows users to perform even computations with high output needs. Based on these great computational resources, it has been possible to perform multiple parallel runs testing different set-ups. The final runs employed between 16 and 40 cores, allowing an impressive wall clock time speed-up of our computations.

Results

The overall machine performances in terms of mechanical efficiency are reported in Figure 9 where it is also possible to correlate the efficiency trend respect to the adopted discretization scheme: analyses are performed with increased complexity and accuracy in terms of gradients resolution so that each run presents higher average

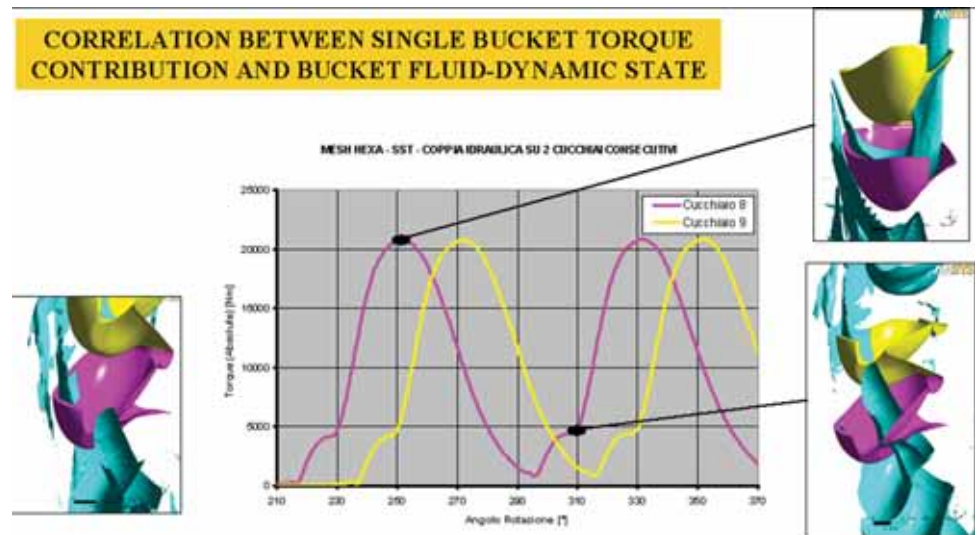


Fig. 11 - Correlation between single buckets' torque contributes and their fluid-dynamic state

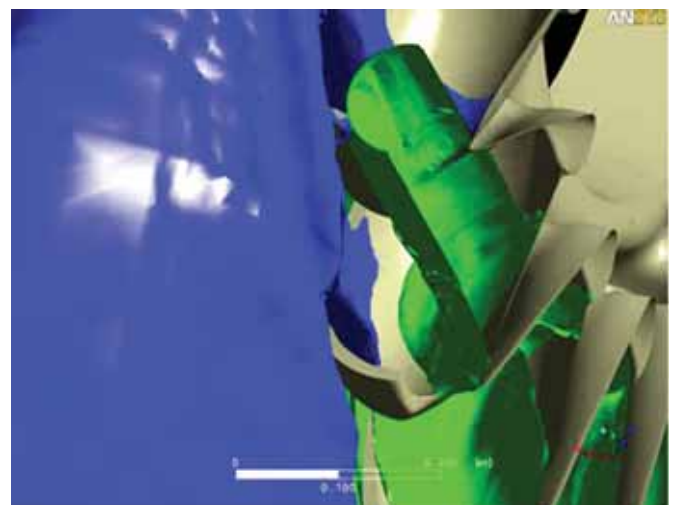


Fig. 12 - Distinct tracers in each water jet allow to verify the absence of interaction between them



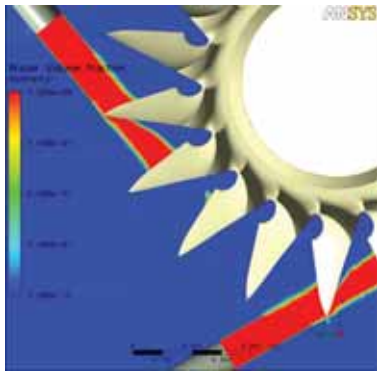


Fig. 13 - Water volume fraction on the turbine's axial midplane

benefits of CFD is presented in Figure 12, where we can verify the absence of interactions between the two water jets.

Maps and contours of different quantities on the machine's midplane are shown in Figure 13 – Figure 16. In particular, Figure 16 helps to estimate water drops recirculation in the near wheel region.

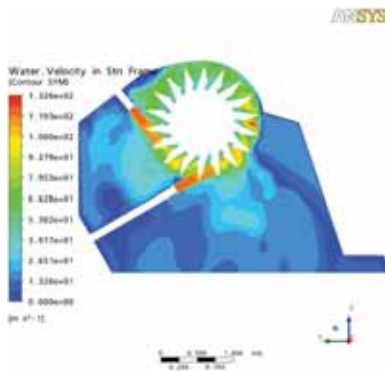


Fig. 14 - Water absolute velocity on the turbine's axial midplane

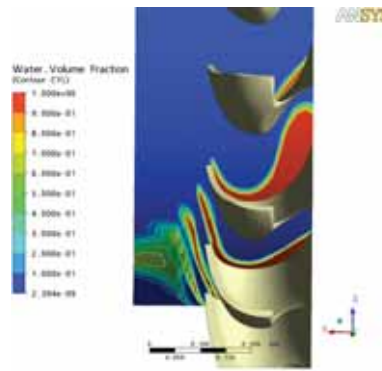


Fig. 15 - Water volume fraction on a bucket frontal cutplane

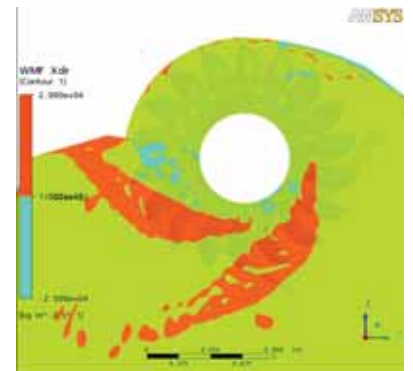


Fig. 16 - Water drops recirculation displayed on the turbine's axial midplane

The analyses also took the cavitation phenomena into account: Figure 17 highlights a bucket surface area with high cavitation tendency.

Finally, monophasic analyses were performed with air only returned from the aerodynamic rotor losses.

Conclusions

For the renovation and upgrade of a hydropower plant, a fluid-dynamic analysis of a full-scale model of a Pelton turbine has been carried out.

The use of CFD has enabled the engineers to overcome the machine's intrinsic complexity and to achieve the following:

- Various turbine performances could be analyzed, for example: hydrodynamic torque and power output as well as

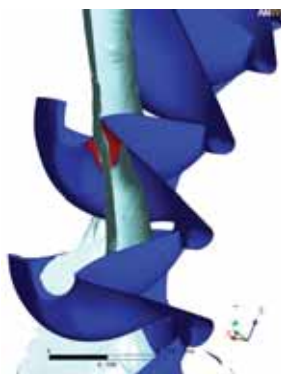


Fig. 17 - Detail of a bucket surface area with high cavitation tendency

- the magnitude of these quantities' and their fluctuations.
- Detailed resolution of the water jets interaction with the wheel's buckets.
- Successful verification of the absence of mutual jet interaction.
- Detailed 3D study of the water path on the bucket and of the fluid layer thickness.
- Linkage of each single bucket's fluid-dynamic state with its actual contribution to the total shaft torque.
- Verification of the entity of the stator frame water recirculation phenomena in the wheel proximity
- Evaluation of the cavitation tendency of the machine
- Estimate of idle losses with free-to-air running wheel.

Franco Tosi Meccanica has benefited from the work performed and the applied technologies as indicated by the described results. Moreover, the company could model strategic technological developments. HPC resources played a crucial role too, speeding-up computing time thanks to EnginSoft's resources.

Future project work will focus on evaluating more complex non-homogeneous multiphase models, post-processing macros to easily calculate flow angles on buckets and, finally, new partitioning algorithms, such as the Coupled Domain Multipass Partitioning, available in ANSYS CFX 12 and applied to increase calculation speed and robustness.

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LS-DYNA and modeFRONTIER for Material Model Calibration at Automobili Lamborghini

CFRP composites have been used in Automobili Lamborghini since 1983. Today, the main challenge is to reproduce their structural behavior by developing suitable numerical models whose set-up requires just simple experimental tests. Automobili Lamborghini and EnginSoft started a collaboration to perfect sophisticated manufacturing applications and FE technical support with the aim to provide such numerical models.

1. The rationale

The procedure described in this article allows to define reliable numerical material models for the accurate prediction of the static and dynamic behavior of real components (including those with complex-geometries), without performing dedicated experimental test campaigns. In particular, two different composite materials, "RTM 1400" and "PREPREG 977- 6", have been investigated with the



While the engineers relied on modeFRONTIER's capabilities, the procedure has been to calibrate the constitutive parameters of LS-DYNA's advanced material models, and to use them for prediction, design optimization and robustness analysis. In this way, the amount of expensive experimental tests could be reduced. This approach also allows better understanding of the influence of physical and geometrical variables on the composite dynamic structural response or, respectively, to obtain improved solutions for industrial case studies.

objective to exploit the calibrated material models in impact situations of automotive structural components. While we describe here only the "RTM 1400" modeling with a "MAT 58" LS-DYNA material card, the procedure has been validated by applying it also to "PREPREG 977- 6", where it delivered similar accurate results of the numerical model.

In order to obtain a good and robust numerical-experimental correlation, the calibration of the parameters has to be performed taking into account the material behavior in

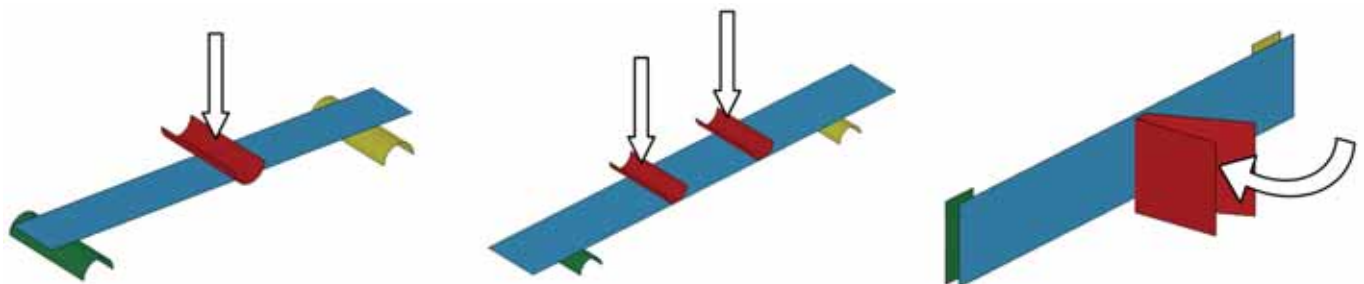


Fig. 1 – Three Points Bending test, Four Points Bending test, Charpy Pendulum test



different load conditions. For this reason, we use different objective functions, which represent the material responses, and have to be achieved simultaneously. Hence, the calibration process can be tackled as an optimization challenge with material constitutive parameters as input variables to be optimized accordingly to different conflicting goals.

To this purpose, LS-DYNA has been coupled with modeFRONTIER, a Process Integration and Design Optimization tool that is capable of exploring the design space (i.e. the free parameters dominions) and finding the configurations which satisfy several objective functions (i.e. the specimen response in different loading conditions). This tool allows also to assess the smaller set of experimental tests needed to achieve a reliable static and dynamic mechanical characterization, by means of its sensitivity analysis capabilities. Furthermore, modeFRONTIER and LS-DYNA can be applied together in the design phase (as well as with other disciplines' models in the loop), with the aim of optimizing the overall assembly parameters respect to multiple attributes, such as impact behavior, manufacturing cost, weight, size, etc.

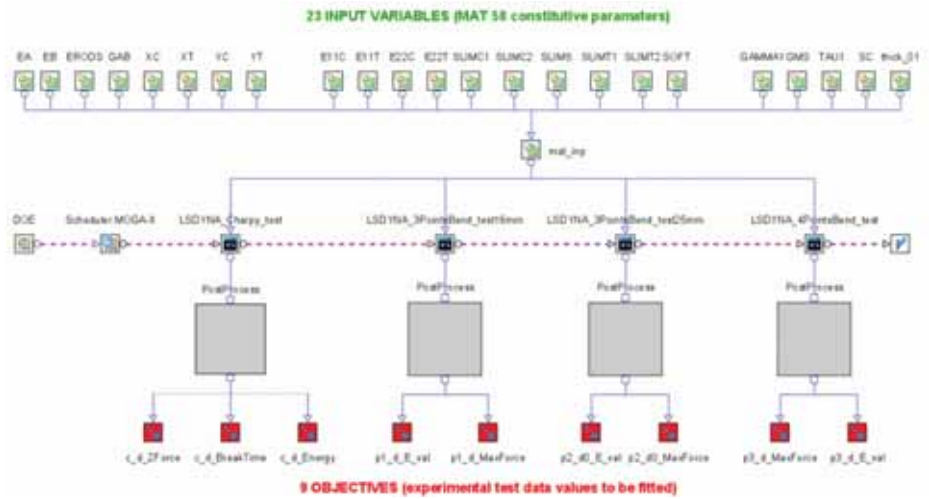


Fig. 2 – modeFRONTIER – LS-DYNA workflow

geometry (rectangular cross section bar), the following four destructive tests have been selected and performed:

- 3 Points Bending Test (16mm width specimen);
- 3 Points Bending Test (25mm width specimen);
- 4 Points Bending Test;
- Charpy Pendulum Test.

The Global Stiffness and the Total Absorbed Energy quantities have been measured for 3 and 4-Points Bending tests, while Absorbed Energy and Local Failure Mode were selected for Charpy Pendulum. For these quantities, 9 objective functions to be minimized (nine relative errors) were considered in order to investigate the material behaviors.

2. Setting up the procedure

The set-up of the procedure firstly required the selection of a set of simple experimental tests to obtain proper data fitting, and also to integrate the finite element LS-DYNA models into the modeFRONTIER environment.

2.1 Selection of experimental tests

The experimental tests should describe in an accurate way the different material behaviors under different loading conditions, avoiding at the same time information redundancy. By using the same ASTM D 790 specimen

2.2 Process Integration:

modeFRONTIER – LS-DYNA workflow

As the LS-DYNA material model calibration process is characterized by a large number of goals (i.e. the 9 objective functions) and design parameters (MAT 58 – MAT_LAMINATED_COMPOSITE_FABRIC – selected as the most suitable to describe the composite sandwich which requires 23 input variables), it cannot be solved by using a simple trial-and-error procedure. The efficient method we propose here, instead, takes advantage of the modeFRONTIER Process Integration and Design Optimization capabilities.

The process integration of the numerical models related to the experimental tests can be implemented and described within modeFRONTIER by means of the workflow illustrated in Fig. 2.

From top to bottom, following the blue links, the so-called “Data Flow” can be seen. The green block at the top defines the input variables (the constitutive parameters) for which a suitable range of variations can be set. Each time a new combination of their values is proposed by the modeFRONTIER optimization strategy, the MAT 58 card file is updated (node “mat_inp”) and transferred to the four LS-DYNA models. These computations deliver outputs that are

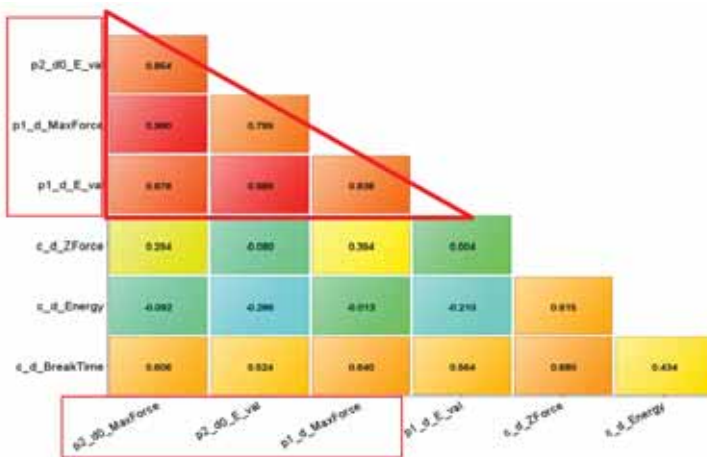


Fig. 3 - objectives' Correlation Chart



post-processed and finally provide numerical forecasts of the nine physical responses, whose values are re-arranged in the nine relative errors with the aim to minimize the discrepancy (red blocks).

From left to right, following the dotted link, the so-called "Logic Flow" is shown: it represents the sequence of operations that modeFRONTIER will automate, and the logic behind them. The "DOE" node, the first block on the left side, means "Design Of Experiments". This node allows the user to design a suitable initial population (combinations of input variable values) in respect of an efficient exploration of the design phase. Looking at the performances provided by these configurations, the "Scheduler" node realizes how the investigated phenomena behave and based on its internal search strategy, starts to generate completely new designs. The new configurations flow sequentially into the four LS-DYNA models, whose numerical simulation is run in batch modality by modeFRONTIER, so that eventually a new evaluation of the objective functions is performed.

In this way, the workflow describes in a graphical and a very intuitive way, how the whole process is carried out.

3. Calibration and validation procedure

The whole procedure is composed of 3 fundamental steps:

- 1) Check outputs' correlations to reduce number of experiments;
- 2) Check for the least-influential inputs to reduce their number;
- 3) Calibration and validation procedure.

In the first two steps, a numerical-experimental data comparison is performed in respect of all experimental tests. No optimization (and consequently no calibration) is carried out, as only the designs that belong to the initial DOE are evaluated. By selecting a suitable DOE (full or reduced factorial, latin square, etc.), it is indeed possible to point out both, the correlations between the different objective functions and the correlations between the constitutive parameters as well as the objective functions.

Getting the outputs-outputs relationships (1st step), allows reducing the calibration challenge size because the correlated outputs (i.e. the redundant ones) can be omitted, as well as a whole experimental test. Fig. 3 – objectives' Correlation Chart – highlights the first-order correlation between two entities by means of a normalized index spanning from -1 to +1: a value equal to +1 (-1) denotes a full direct (inverse) correlation, while a low absolute value means low correlation. In such cases, the outputs of the two 3-Points Bending tests are strongly directly correlated

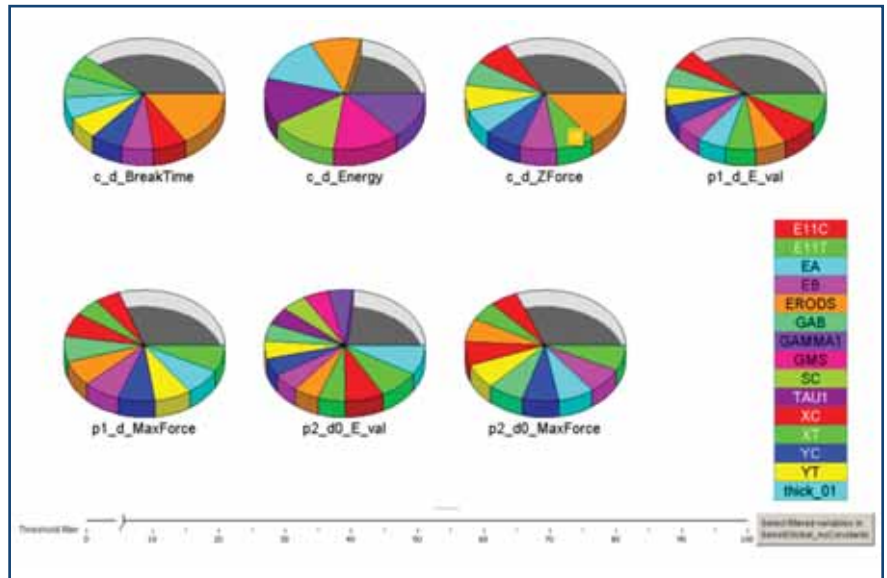


Fig. 4 - Overall Student Chart

between themselves, hence only a single Point Bending test can be taken into account. Thus the number of objective functions can be reduced (currently from nine to four objectives).

At the same time, highlighting the correlations input-output (2nd step) enables to freeze, at a constant value, the least significant input variables. Thus the number of input variables can be reduced. For this purpose, a Correlation Chart sketching both input and output variables could be used. Another efficient tool is the so-called Overall Student Chart; based on Student's t-test, it is extremely useful to easily detect simultaneously which input variables are the least sensitive ones for the set of objectives functions.

In particular, as shown in Fig. 4 – Overall Student Chart – every objective function is given by means of a pie chart. In the pie chart, those input variables that affect more than a given threshold are highlighted while the least sensitive ones are grey-shaded and hidden from the table at the right side of the picture after moving the "threshold filter" at the bottom. The input variables reduction (currently from 23 to 15) allows to get a faster model calibration.

In the 3rd step, the modeFRONTIER workflow has been simplified according to the above findings, and the multi-objective optimization campaign started with the Multi-Objective-Optimization-Algorithm MOGA-II. A calibration using only the most sensitive input variables and non-correlated numerical models has been carried out. The optimization strategy provided, in less than 4000 evaluations, three candidate optimal solutions: they are red-framed in Fig. 5 – 4-Dimensional Bubble Chart – where each solution is represented by a bubble in the 4-D plane of the objectives. A good configuration should stay bottom left in the chart (low "c_d_Energy" and "p3_d_MaxForce" deviations from experimental data), should be blue (cold)-colored (low

"p3_d_E_val") and look like a small-sized bubble (low "c_d_BreakTime"). The three selected configurations are good compromises between the simultaneous reduction of the four uncorrelated percentage deviation indexes, selected from the Charpy and 4-Bending Points tests.

The full validation has been eventually assessed by inserting the optimum candidates coming from the previous calibration into the complete workflow: one-digit % deviations from experimental values have been confirmed also by the remaining five objectives.

4. Conclusions

A material model calibration procedure has been proposed by coupling LS-DYNA and modeFRONTIER. The procedure has been tested for RTM1400 composite modeling with a MAT58 material card, and delivered good results within a two-weeks time frame (once experimental data has been available), on an ordinary workstation. This method also allows to identify the minimum set of experimental tests needed to characterize the material model, out of a set of available ones. In the example presented in this article, these are the Charpy and 4-Points Bending tests.

It is relatively easy to implement the whole procedure into modeFRONTIER, as the software allows a straightforward process integration and supports the user to build up the more suitable multi-objective optimization strategy. At the same time, the post processing environment is very intuitive to use.

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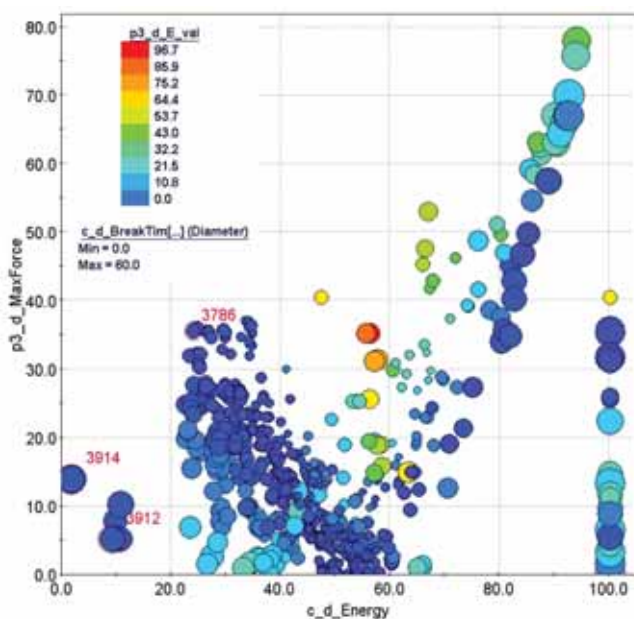


Fig. 5 – 4-Dimensional Bubble Chart

Simulation of carbon fiber materials with ANSYS

The scope is to develop a support with integrated cooling for the future replacement of the inner layer of the Pixel Detector installed into the ATLAS Experiment for the LHC accelerator at CERN.

The task is to hold the detector sensor modules in positions with high accuracy, minimizing the deformation induced by the cooling to - 40°C with the lowest mass. An evaporative boiling system to remove the power dissipated by the sensors is incorporated into the support: the thermal contact is made through a light and high-conductive carbon foam to maintain the sensor temperature low and so limiting electronics thermal run-away. The coolant would be a fluorocarbons blend or CO2 and the pipe material Carbon Fiber or Titanium. The design is based on thermo-structural analysis of assemblies made of carbon composites.



Thermal performance and evaluation of the thermal expansion coefficients of the different configurations proposed have been made together with calculation of the pressurized pipe Tsai-Hill safety factors and transversal strain, that is the parameter that controls the micro-cracks growth in the ply, limited for the tightness assessment of the pipe. Pipe lay-up optimization has been made together with estimations of the thermal expansion coefficient of the laminates. The layered elements of the software ANSYS can be used, with some care, as a useful tool for the analysis of models with composite materials. A lot of work has been devoted to understanding the method and to build the models for the various simulation goals.

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Errata Corrige:

In the article "Simulation of carbon fiber materials with ANSYS" published in the EnginSoft Newsletter Year 6 n.4, page 29 the author reference was missed: Ing. Simone Coelli, Istituto Nazionale di Fisica Nucleare - simone.coelli@mi.infn.it



Analisi strutturale di uno scarpone da sci alpinismo e ottimizzazione del rapporto peso-prestazioni

Lo scarpone da sci è un settore dove l'investimento in ricerca è sempre stato elevato. La resa strutturale dell'elemento che collega il corpo allo sci è fondamentale in quanto definisce il controllo e la sensibilità nella sciata al pari degli ammortizzatori di un'automobile.

Nel mercato dello sci è emerso negli ultimi anni una notevole richiesta di prodotti specifici per lo scialpinismo. Questa pratica, a differenza della discesa, necessita di una calzatura che col minimo peso combini la massima mobilità in camminata con una buona rigidità in discesa.

Queste esigenze sono in contrasto fra di loro:

- la mobilità in camminata è realizzata da un gambetto incernierato allo scafo, che ruota seguendo la gamba nel suo movimento senza ostacolarlo;
- la rigidità in discesa si ottiene sempre incernierando un gambetto allo scafo, ma bloccando ogni movimento di rotazione e controllando l'assorbimento delle sollecitazioni attraverso la deformazione delle plastiche;
- nella discesa il peso dello scarpone non è importante, anzi, spessori elevati spesso permettono migliori risposte strutturali a vantaggio dell'energia di conduzione della sciata; viceversa nella salita la leggerezza è un elemento fondamentale per diminuire la fatica.

La Sportiva di Ziano (TN) è un'azienda già presente nel settore dell'alpinismo con prodotti di alte prestazioni. Nel 2009 ha introdotto sul mercato il primo scarpone da scialpinismo completamente in fibra di carbonio: la tecnologia è molto efficace, combinando alte prestazioni strutturali con minimo peso, tuttavia il costo rende il prodotto accessibile solo ad agonisti ed appassionati.

Nello stesso periodo ha dato incaricato per la realizzazione di un nuovo scarpone da scialpinismo in materiale termoplastico a Dna srl, una società di industrial design di Trento con esperienza nello studio e nello sviluppo di scarponi da sci.



Ad EnginSoft è stata affidata l'analisi strutturale e lo studio dell'ottimizzazione della struttura: lo studio di un modello completamente nuovo infatti non poteva prescindere da un'analisi strutturale che ottimizzasse il rapporto peso-prestazioni in condizioni di camminata e discesa.



La prima problematica affrontata è stato definire il tipo di sollecitazione a cui sottoporre la struttura. Non avendo a disposizione uno storico di dati reali l'analisi è stata di tipo qualitativo: questo significa sottoporre la struttura ad uno sforzo unitario e analizzare la distribuzione qualitativa delle deformazioni, supponendo un comportamento lineare fra forza applicata e deformazioni. La forza unitaria viene applicata sulla sommità anteriore del gambetto in direzione perpendicolare alla gamba.

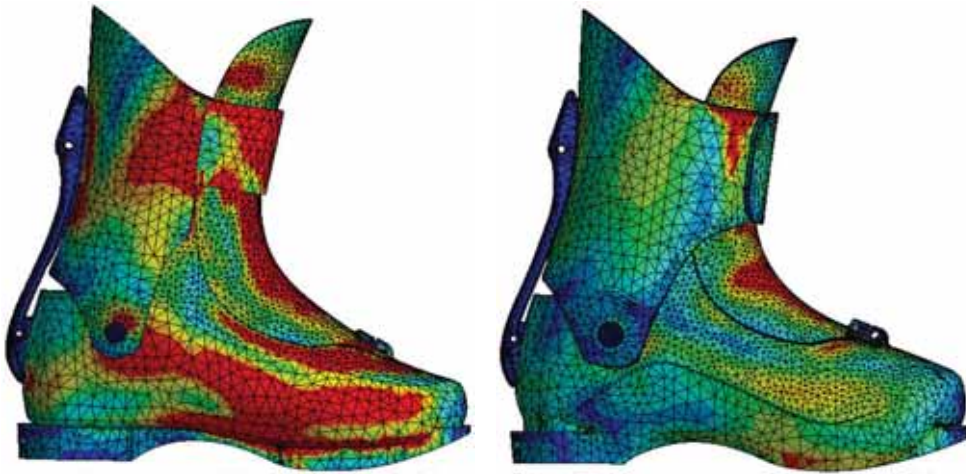
L'obiettivo è quello di definire le aree di irrigidimento della struttura fissando il peso. Per fare questo è stato creato un modello 3D a spessore costante ottenuto come offset della forma interna dello scarpone.

La forza unitaria applicata a questo modello ha dato la disposizione delle deformazioni visibile nell'immagine. Possiamo notare 4 aree principali di deformazione (colore rosso):

- a. punto di flesso sulla lingua;
- b. zona laterale alta gambetto;
- c. laterale e suola zona avampiede;
- d. area borchia di fissaggio scafo-gambetto.

Il modello 3D è stato rielaborato introducendo una linea di rinforzo laterale sullo scafo e adeguando gli spessori in modo da rinforzare le aree deformate, ma senza aumentare il peso complessivo della plastica.





Il risultato, a pari forza applicata, è riportato nelle immagini allegate: si può notare la notevole riduzione delle deformazioni.

Il cedimento in avanti del gambetto si è ridotto del 24%, testimoniando la riduzione della flessione complessiva senza che questo comporti un aumento del peso della plastica.

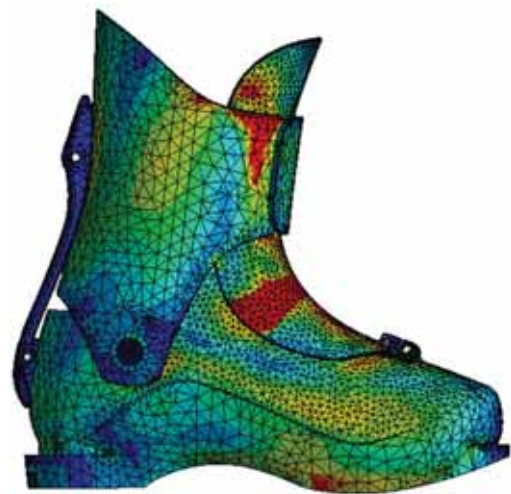
Il secondo obiettivo era quello di capire il contributo della lingua nella rigidità a flessione: la lingua infatti è l'elemento che impedisce maggiormente la mobilità in camminata.

La lingua ha un punto principale di flessione al centro, dove il piede si curva; una lingua con una grossa raggiatura crea una flessione graduale, viceversa un piccolo raggio nel punto di flessione crea un cedimento immediato. Se poi nel punto di flessione creiamo una cerniera (ad esempio utilizzando una doppia iniezione plastica rigida-morbida) la forza di flessione verrà completamente scaricata alla struttura scafo - gambetto - meccanismo posteriore. Abbiamo analizzato cosa succede in questa ultima ipotesi.

La distribuzione delle deformazioni è molto simile alla versione con lingua rigida, con un aumento delle deformazioni. La differenza si nota nel cedimento sul gambetto, ridotto solo dell' 11% rispetto alla soluzione iniziale, circa la metà rispetto alla versione precedente.

Questa differenza è dovuta alla necessità di avere una struttura mobile in camminata.

Alla fine dello studio strutturale è stato realizzato un prototipo rapido per la verifica e la messa a punto dell'estetica complessiva dello scarpone. Il modello 3D è stato utilizzato per fare uno stampo da iniezione da cui sono state realizzate con materiali definitivi le campionature per test su neve.



Il metodo tradizionale per lo sviluppo di un nuovo scarpone avrebbe previsto l'esecuzione di un prototipo in resina realizzato a mano con successiva scansione e reverse engineering. L'analisi della struttura sarebbe avvenuta empiricamente con test su neve dei prototipi ottenuti per colata da stampi in silicone.

Durante lo sviluppo di questo progetto invece è stato possibile lavorare con un processo diretto, quindi realizzare le matematiche della forma e applicare successivamente

gli spessori della plastica attraverso l'analisi strutturale; questo ha permesso di avere le scarpe test nel materiale definitivo in 6-7 mesi di lavoro, circa la metà dei tempi tradizionali, ma soprattutto ha permesso di centrare la struttura del prodotto limitando ulteriormente i tempi e i costi di messa a punto.

Un'ultima considerazione sulla struttura: in entrambe le ipotesi il sistema scafo - gambetto - meccanismo posteriore funziona nella flessione in avanti come un telaio triangolare dove il meccanismo posteriore è un tirante e il gambetto un puntone. All'aumentare delle forze, soprattutto in situazione dinamica, la condizione di linearità non è più valida poiché alcune zone vengono sollecitate con carichi di punta e con deformazioni considerevoli. Le deformazioni si concentrano in particolare nella zona della borchia dove il carico di punta causa degli spancamenti sia sul gambetto che sullo scafo. Solo l'introduzione di elementi strutturali in carbonio in questa zona permette di avere un miglioramento consistente della rigidità senza aumentare il peso dello scarpone. Questo tipo di analisi potrà essere il tema di un nuovo studio.

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1D Simulation and Optimization of a Formula SAE four cylinders engine

Formula SAE (Society of Automotive Engineers) is an international racecar competition which attracts engineering schools from around the world.

Formula SAE (Society of Automotive Engineers) is an international racecar competition which saw the participation of the University of Salento in the last three years (2006-2008-2009). For the races, two different cars were designed by the Salento Racing Team, a group of students dedicated to automotive design and production. Engine and powertrain simulation, prediction of experimental results and engine intake optimization are among the most important activities of the team's Engine & Drivetrain Division.

For the next car, the plan is to have it equipped with a four cylinder engine which will be optimized to comply with the general rules of the competition. One of these rules requires to place a 20 mm restriction along the main intake duct with the purpose of reducing power at highest engine speeds. The first step of the simulation work was to create a correct and simple model of the engine in order to analyze all resonance phenomena occurring in both the intake and exhaust systems.



The next step was to create a parametric version of this model, in order to allow a fluid and geometric optimization process of ducts and resonance plenum, with the aim to determine the main geometric values of previous systems. The planning of a future optimization is currently in progress which should define, in detail, the geometry of each component with the primary objective to achieve maximum performance in terms of engine torque and power.

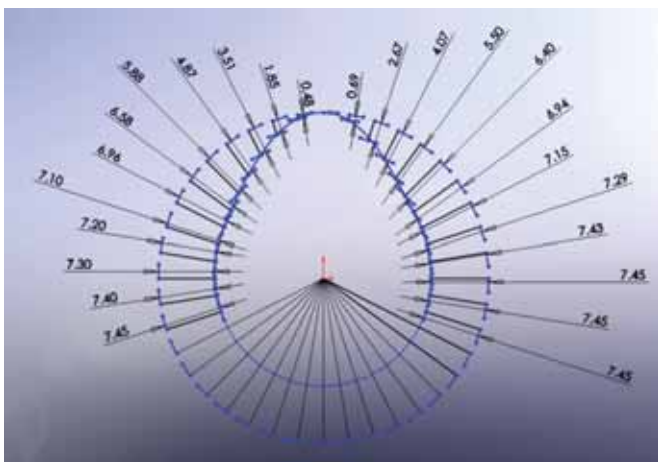


Fig. 1 - Cam profile reconstruction

1D AVL Boost model

Optimization results strongly depend on the accuracy of the 1D engine model. The 1D model has to be very accurate and simple at the same time to reduce computational cost. After a simulation of the original configuration of the engine, we chose a new exhaust system and a particular intake system layout suitable for achieving good values of torque for different engine speed. A variable intake system, with telescopic ducts, is the best choice to maximize inertial and wave effects in in-line reciprocating engines. This approach required measurements and a very good parametric CAD model of the intake and exhaust cams. A qualitative analysis of different general exhaust system layouts allowed to find a good compromise between many different solutions.



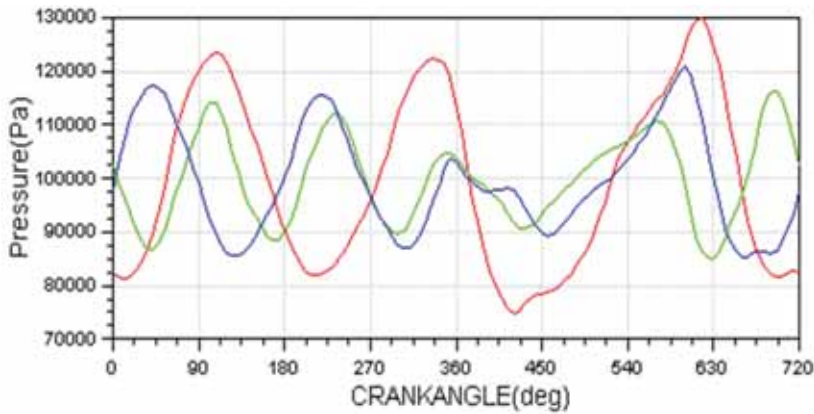


Fig. 2 - Waves behavior in the intake system for various engine speeds

During the system modeling phase, the focus was to describe perfectly the geometrical and the physical characteristics of the pipes and ducts. On the other hand, many other factors were not significant for this study; for example, the combustion phase was not modeled in detail as all results were referred to an open-valve analysis. The 1D model was created using AVL Boost® software.

Optimization strategy and objectives

The choice of input and output variables was important. We chose four general input variables and a single objective variable. A previous optimization was finalized to fix a reasonable volumetric capacity of the plenum, which is a large box of the intake system with a function to dampen the undesired effects of the restriction. The algorithm used is a traditional MOGA II genetic algorithm.

Torque is the output variable selected as the objective to be maximized and the length of the four pipes is the input variable. After these optimization phases, a new model was created with the new geometry of the ducts.

Each engine speed now had its optimized intake

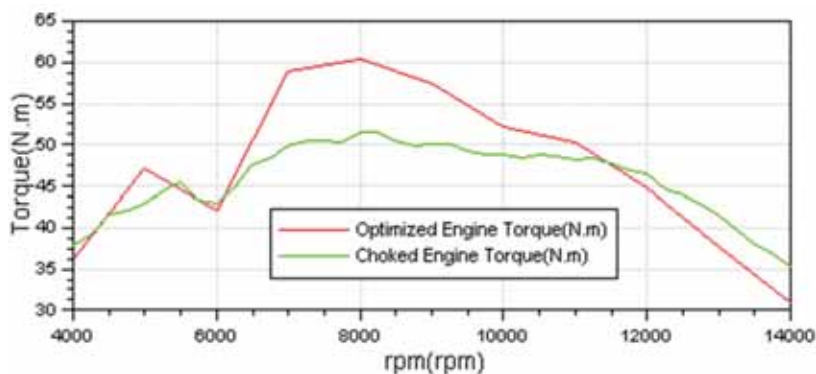


Fig. 3 - Engine performance after the optimization process

length. Therefore, a variable intake length control on the new AVL Boost model was implemented in order to predict the behavior of the engine. The optimization process also provided many different exhaust systems for different engine operating conditions. In our case, modeFRONTIER found the best compromise. The modeFRONTIER tools were very helpful during both the optimization and post processing phases.

Optimization results

The Optimization delivered an improved torque for a large range of engine speeds. In fact, the restriction on the main intake duct causes a drastic reduction of volumetric efficiency and engine torque (green line in Picture 4). The final solution was chosen in order to have a high torque at medium-low engine speeds. In

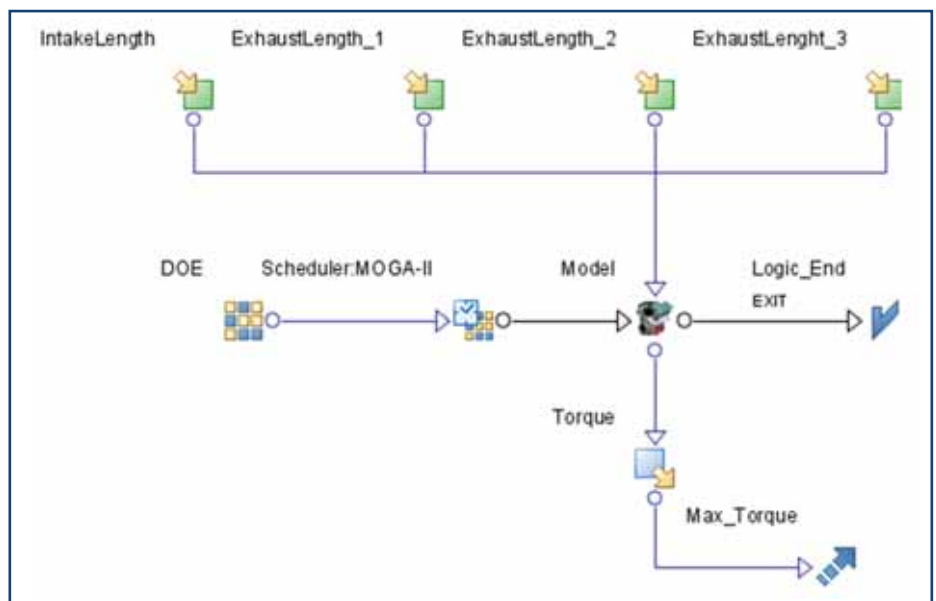


Fig. 3 - modeFRONTIER Flow Work

fact, this is what is needed for the engine for this type of race. At medium-high engine speeds, performance worsening is acceptable because it preserves the engine structure and reduces friction losses related to fluid velocity.

Conclusions and next steps

By using Optimization, a totally new behavior of the engine could be established, and an improved performance, compared to the choked configuration, could be achieved.

A 3D CFD simulation is now necessary to define in detail all the micro-aerodynamic geometries of every single component. Afterwards, a further 1D optimization phase will define the final layout of the exhaust system.

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Numerical Simulation for Performance Based Design of Complex Structures Subject to Fire

Nel presente articolo si presenta l'applicazione dell'approccio prestazionale per la verifica di resistenza al fuoco di una struttura complessa: un padiglione destinato ad ospitare fiere espositive costituito da pilastri in cemento armato e copertura in travi reticolari in acciaio.

Per strutture complesse, questo approccio è preferibile rispetto al tradizionale approccio prescrittivo. In funzione delle prestazioni richieste e di scenari di incendio ritenuti sufficientemente realistici, sono state condotte analisi numeriche mediante un codice di calcolo di fluidodinamica computazionale [1] (FDS) [2], [3] per determinare l'effettiva azione da incendio sulla struttura. Tale azione è stata applicata nel programma FEM Straus7/Strand7 [4] al fine di stabilire la risposta strutturale e di determinarne la resistenza al fuoco.

The aim of this article is to highlight the application of a performance approach to the fire design of a complex, structure, such as an exhibition pavilion with concrete columns and reticular steel beams. For complex structures, the performance-based approach is more adequate than the traditional prescriptive approach.

Analyses have been performed by means of a computational fluid dynamic computational code [1] (FDS) [2], [3] in order to determine the impact of fire on the structure in view of required performances and realistic scenarios. The work has been done using the FEM program Straus7/Strand7 [4] in order to establish the structural behavior under fire exposure.

Introduction

Modern codes allow two methods to design structures subject to fire: the prescriptive approach and the performance approach. In some cases, the first method may be

inadequate. In case of complex structures, where it is impossible to respect all architectural requirements requested by the prescriptive approach, the performance-based approach is more appropriate to obtain the optimal structural behavior under fire.

This work focuses on the application of the performance approach to an exhibition pavilion, rectangular shaped with sides of 144 and 72m. The structure is strongly redundant. It consists of 24 columns in concrete. Horizontal elements are 11 spatial reticular beams in the minor direction - Figure 1 provides an example - and 3 in the other direction. The structure has two openings 36x6 m in the centre of the minor sides.

The Performance-based Design Approach

The main features of the Performance-based approach are synthesized below:

Goals:

It is necessary to predict not only the structural resistance, but also the level of damage in case of fire in order to assure

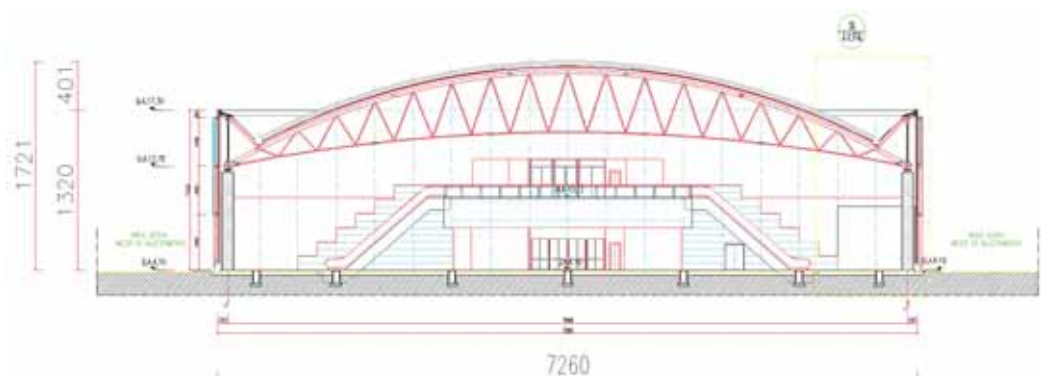


Fig. 1 - Case study: typical sections of the structure

an appropriate performance. In this case, it should be level 3, as stated in Eurocode: structures must have requisitions of resistance to fire, such that they can hold out total combustion of any combustible material, within the whole building or in a specific zone of it, without considering the action of the rescue team.



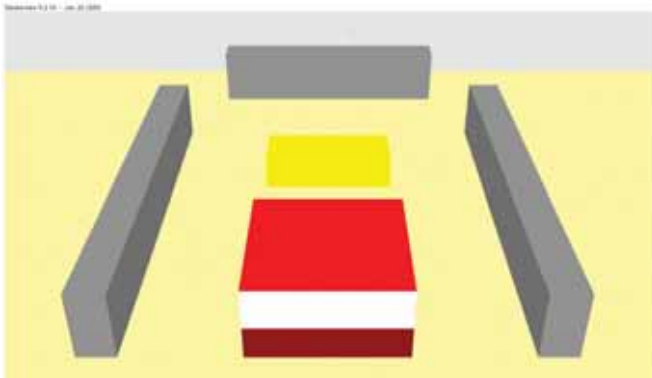


Fig. 2 – Typical fire sources.

Performance, Performance Criteria and Performance Limits:

The definition of structural collapse is to be carefully considered for this type of structure. The failure of a single steel member does not produce the collapse of the full structure. It is possible to consider a limited deformability for a group of elements, so that the vertical displacements of some key points can be assumed as performance indicators.

Scenarios:

According to the definition of the scenario given in ISO/TS 16733 [5], the following aspects have to be specified for a whole description of fire scenarios:

- source of fire;
- nature and physical characteristics of combustible materials;
- growth rate of fire and peak rate of heat released.

Given the use, it is realistic to think about the presence of stands inside the structure; each of them has been assumed as formed by a wooden table on top of which lies some paper, surrounded by three plastic shelves and two sofas, as illustrated in Figure 2.

In order to estimate the evolution of fire within the structure, six scenarios have been considered, as shown in Figure 3. The source of ignition is supposed to be the paper on the table. According to the directives of the Eurocode EN 1991 – 1 – 2 [6], the following value has been defined:

$$RHR_s = \frac{RHR_{max}}{m^2}$$

based on the use of the structure.

Considering table E.5 of Eurocode [6], the later use of the structure will include shops. This means that fire would develop quickly as it can be seen considering

Scenario	Area[m ²]	RHR _{max} [kW]	t _A [s]	t _B [s]	t _C [s]
1 – 3 – 4	216	54000	1102	1552	2512
2 – 5 – 6	432	108000	1559	2959	3919

Table 1 – Characters of RHR curve in time.

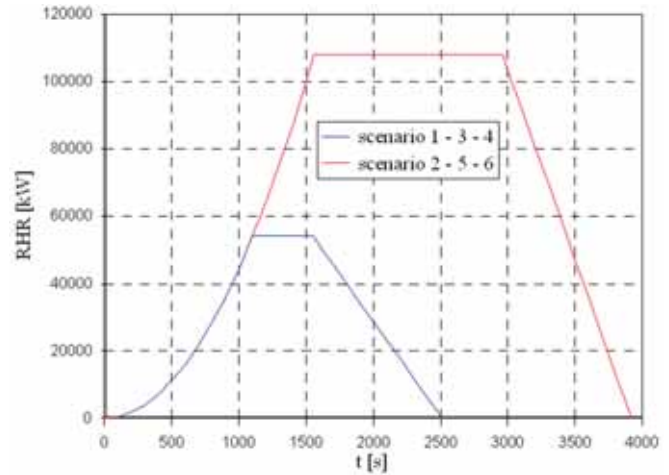


Fig. 4 – Curve describing the evolution in time of thermal power.

$$\alpha = 0.04444 \frac{kJ}{s^2}, \quad RHR_s = 250 \frac{kW}{m^2} \quad \text{and} \quad t_g = 150 \text{ s}$$

In order to construct the corresponding natural fire curves, some procedures taken from current literature have been considered. Then, after the flashover, the heat release rate (HRR) is constant until the beginning of the decay that at

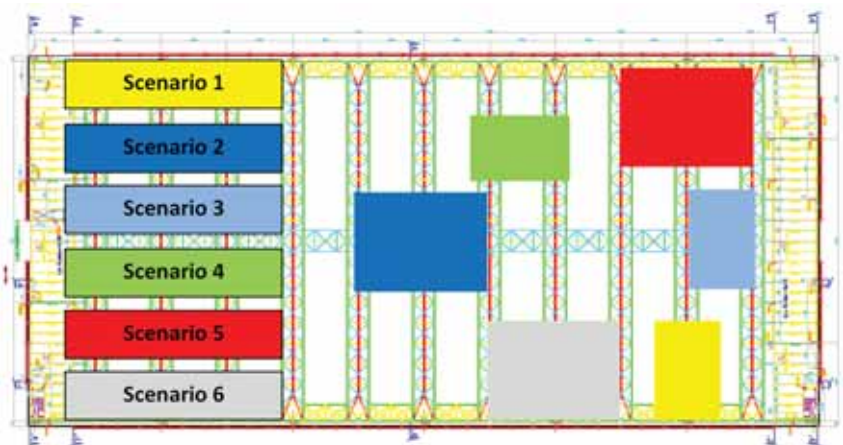


Fig. 3 – Positions of the six scenarios.

this stage occurs according to a linear law. By following upon ISO/TR 13378 – 2 [7] and by considering $q_f = 600 \text{ MJ}$, taken from table E.4 of Eurocode [7], the characteristics of the curve HRR for the six scenarios are those of Table 1.

Figure 4 shows two curves describing the evolution in time of thermal power for all the scenarios.

The analysis is divided in two steps:

1. determination of fire action [8];
2. characterization of fire effects on the structure [9].

Determination of fire action

Three different analyses have been performed by means of a computational fluid dynamic computational code (FDS) [2], [3] in order to determine the action of fire over the structure:

- analysis of sensitivity to the mesh;
- study of boundary conditions;
- determination of thermal map for each scenario.



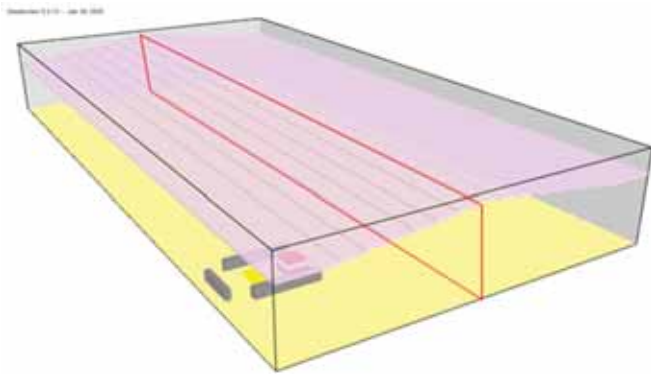


Fig. 5 – Tridimensional model without external environment.

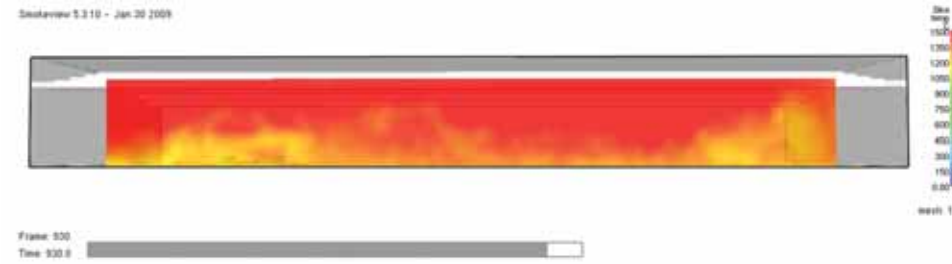


Fig. 6 – Plane of temperature corresponding to the longitudinal central beam.

In the first analysis, the external environment has been considered as a solid at 20°C, as shown in Figure 5. Thus a proof of sensitivity has been elaborated in order to establish the essential accuracy of the mesh.

Parallelepiped elements used in the analysis have dimensions in plan between 1.5 m and 0.5 m, height 1 m, or elements

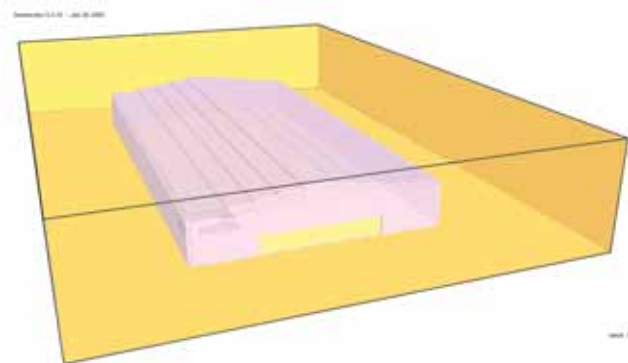


Fig. 7 – Tridimensional model with external environment.

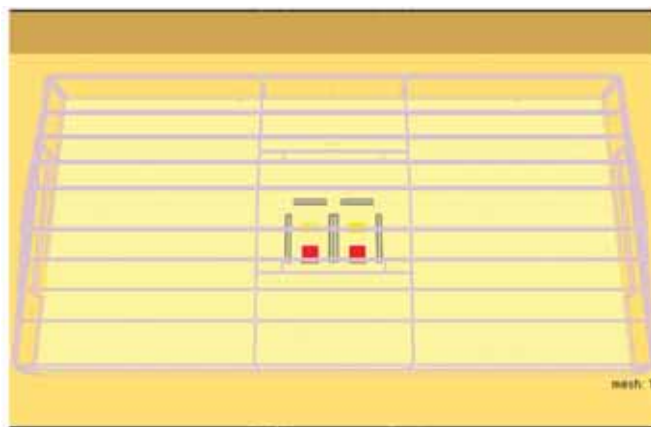


Fig. 8 – Scenario 2 modeled in FDS

sided of 1 m and variable height between 1.5 m and 0.5 m. Given the lack of convergence of the phenomenon, a finer model has been realized. This model is composed by concentric cubic elements. It implies the use of a large amount of elements (440060 at about) and then a growth of the computational burden (70 hours of analysis). In this model, scenario 1 has been analyzed, the flashover happens after 930 seconds. In Figure 6 the plane of temperature corresponds to the central longitudinal beam.

The computation of temperature is strongly influenced by boundary conditions. For this reason, the model has been included in even greater environments in order to determine the role played by boundary conditions.

The initial volume involves 4m beyond the structure in minor direction, 8m in the major one, and 4m in vertical direction. This volume has been enlarged up to 28mX36mX8m as it can be seen in Figure 7. All these models are characterized by a great amount of meshes (more than 1 million) and

by huge computational burdens (up to 10 days). In both cases, the validation of the models is based on the:

- qualitative analysis of the propagation of flame;
- global analysis by means of RHR curve;
- local analysis via temperature-time curves on structural elements and significant sections.

Once the model has been validated, a thermal map of the structure is realized by applying it to the six scenarios.

Figure 8 shows scenario 2 modeling in FDS. Figure 9 and 10 illustrate respectively the occurrence of the flashover and the field of temperatures, which have been observed at the same instant.

The great difference between the application of the nominal curve and the natural curve obtained in FDS is highlighted in Figure 11.

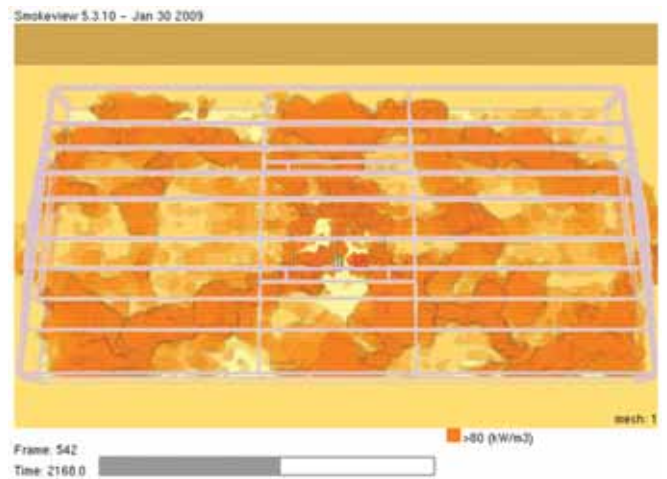


Fig. 9 – Peak of fire.



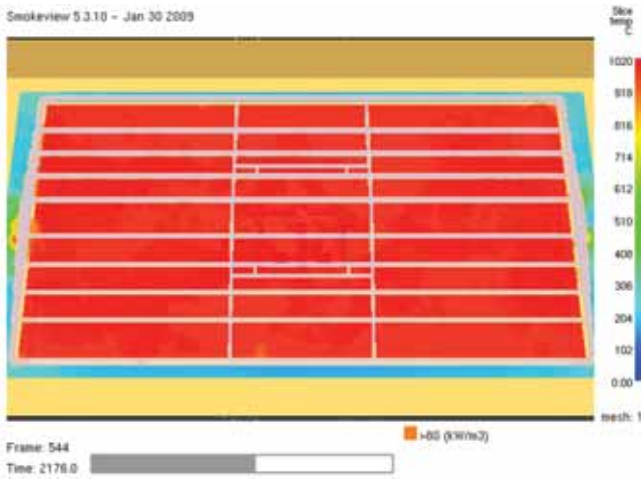


Fig. 10 – Field of temperatures registered during the peak of fire.

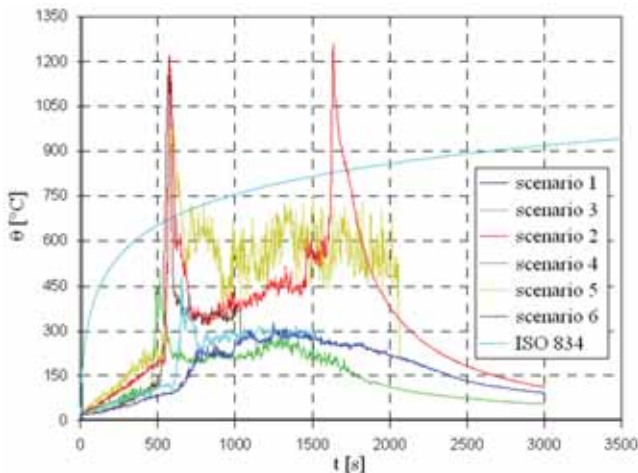


Fig. 11 – Field of temperatures registered during the peak of fire.

Structural analysis

The action obtained has been applied through the program FEM Straus7/Strand7 [4] in order to establish the structural answer [10, 11, 12]. Figure 12 shows vertical displacements of scenario 2 due to the application of the nominal as well as of the natural curve.

Similarly, for the same scenario of load, Figure 14 illustrates the vertical displacement of node 322 (Figure 13). This analysis considers the non linearity of material and the decay of mechanical characteristics under temperature [13, 14, 15, 16, 17, 18].

The difference between the two curves can be explained on the basis of the temperature which has been applied. Whereas a thermal load can be applied outside the scenario using natural curves, it is not realistic to consider the nominal curve outside the scenario.

The good behavior of the structure under fire enables it to reach level 3 of performance required by the Code. Moreover, it emerges the collaboration among the elements. In conclusion, we have to remark the local collapses in some fire scenarios.

Conclusions

In this study, some aspects concerning the numerical analysis for the performance-based design of complex structures subject to fire have been treated. An application on a complex steel structure has been presented. Both fluid dynamic analyses for fire development assessment and structural analyses for structural response investigations have been developed.

The analyses have shown that the use of advanced methods for the numerical simulation of fire behavior is fundamental in order to obtain reliable results for the assessment of the structural behavior under fire. Although simplified methods (use of nominal fire curves) apparently can lead to the same results (same structural deformed shape under fire) as advanced methods (CFD simulation of fire development), a detailed description of the structural response (e.g. details of vertical displacement, time history in critical nodes) highlights the great difference between the structural responses obtained by the two methods. Therefore, the use of advanced numerical simulations is recommended, especially for complex structures.

ACKNOWLEDGEMENTS

The authors wish to thank Ing. Perin of HSH for support connected to the code Straus7/Strand7.

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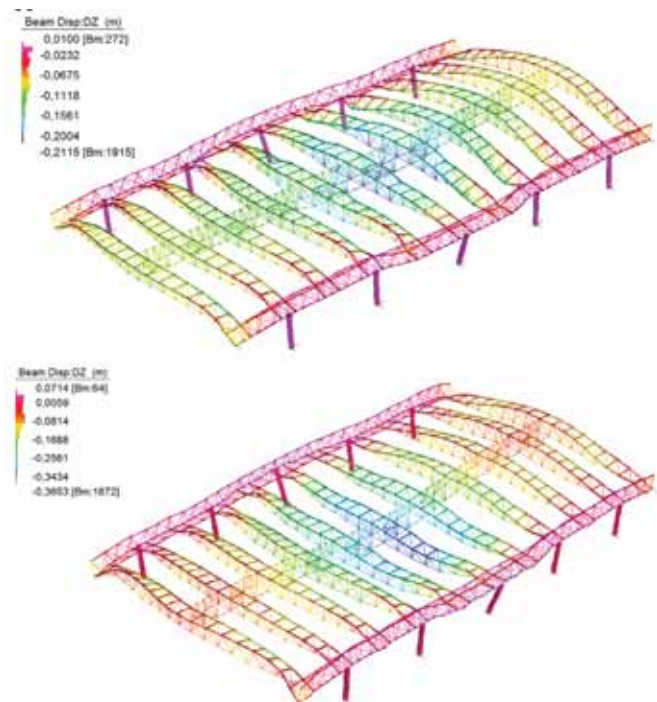
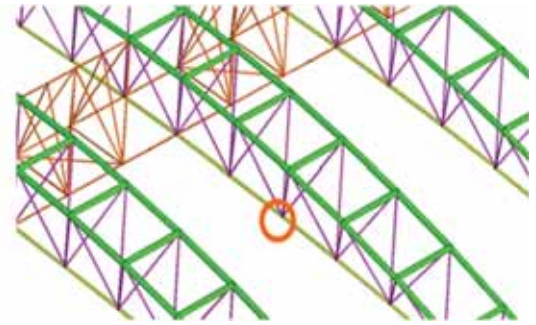
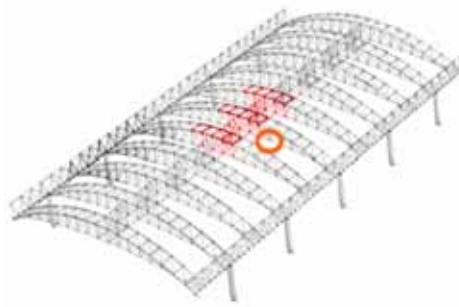


Fig. 12 – Vertical displacements for scenario 2 with nominal and natural curves.



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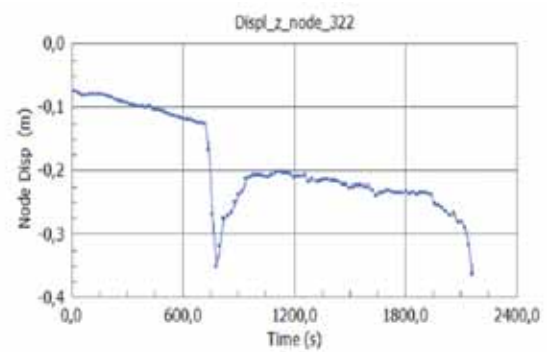
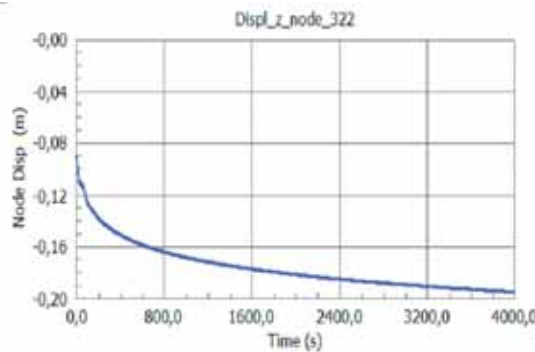


Fig. 14 – Vertical displacements of node 322 for scenario 2 with nominal and natural curves.

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Optimization of Child Restraint System with Load Limiter and Airbag using Child FE Human Model in Frontal Crash

1. Introduction

In 2000, the Road Trucking Vehicle Law was revised in Japan, requiring children under 6 years of age to wear a Child Restraint System (CRS) while in vehicles. As a result, the fatality and severe injury rates for children involved in traffic accidents have decreased [1]. However, since children continue to be injured while wearing a CRS, further crash safety improvement while wearing a CRS is required [2].

CRS crash safety has generally been assessed by experiments or numerical simulations using child dummies or dummy mathematical models. However, child dummies have limited measurement items and hence do not allow detailed assessment of injuries. Their structure and behavior may also be different from an actual child. Due to this situation, a 3-year-old human Finite Element (FE) model has been developed by scaling down the following characteristics of the 50th percentile FE occupant model: body dimension, joint characteristics, and material properties [3,4]. Injuries can be assessed more realistically using numerical simulations with this child human model.

In this study, we investigated the CRS crash safety improvement by numerical simulations, which are more effective than crash experiments since numerous trials are required to improve crash safety while changing the CRS design. The objectives of this study include investigating the influences of a load limiter and an airbag on CRS crash safety and optimizing them for crash safety improvement using numerical simulations. First, the load limiter and the airbag models were modeled and attached to a CRS model. Next, the influence of both models was investigated. Last, we performed optimization of the CRS model using a multi-objective optimization algorithm in combination with Response Surface Method (RSM).

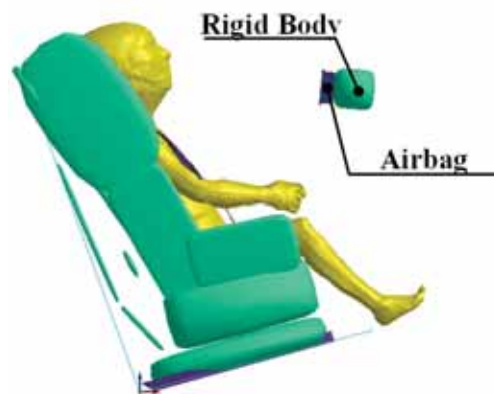


Fig. 1 - CRS Model with Airbag Model

2. Simulation Models

The Hybrid III 3-year-old model, which is generally used for CRS assessment, has limited measurement items and cannot assess detailed injury risks such as bone fractures. Due to this situation, a 3-year-old human FE model has been developed by scaling down such characteristics of the 50th percentile FE occupant model as the body dimensions, joint characteristics, and material properties. This model, which consists of soft tissues, skeleton, and organs, can assess more realistic injuries than the Hybrid III 3-year-old model. To evaluate the biofidelity of the child human model, the model's response against impact was compared to the corridor used in the development of the Q3 dummy.

A frontal thoracic impact test, neck flexion and extension tests, etc. were conducted for model validation. These test results showed that the model was sufficiently validated [4]. In this research, we performed an optimization of the CRS model using numerical simulations with this child human model.

2.1 CRS Model

The CRS model consists of a main body represented in a multibody environment and a 3-point harness represented by FE. The main body of the CRS model consists of 10 rigid bodies, interconnected by two kinds of joints: a revolute joint that has one degree of freedom and a bracket joint that has no degree of freedom. The FE harness model represents the physical harness. The ECE test seat was modeled by two rigid planes, and the CRS model is connected to the test seat by belt elements.

2.2 Load Limiter Model

A retractor scheme with a load limiter model was modeled and attached to the CRS model. The load limiter restricts the load level on the chest by giving out belt material. The load limiter is activated when the belt tension exceeds a specified load in vehicle accidents. Once the load limiter is activated, belt tension remains constant. The retractor was located in the CRS cushion.



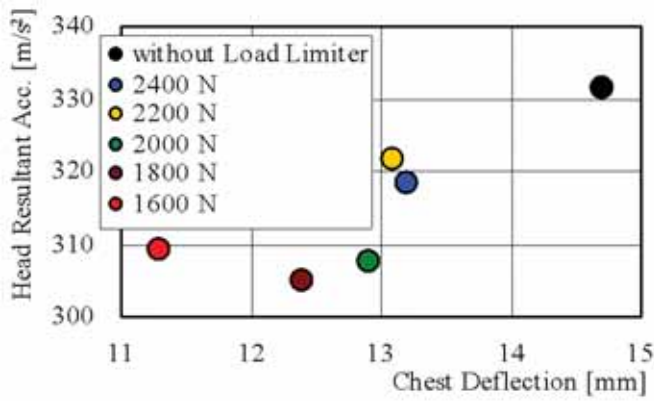


Fig. 2 - Comparison of Head Resultant Acc. and Chest Deflection

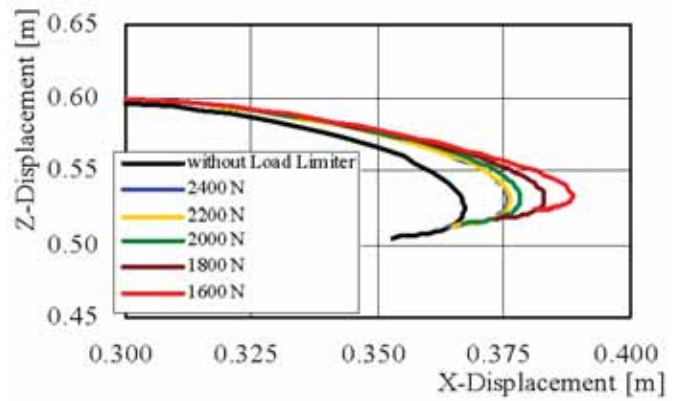


Fig. 3 - Comparison of Head Trajectories

2.3 Airbag Model

Head, face, and neck injuries account for about 80% of all injuries with CRSs [6]. Therefore protecting such areas is important. In this research, we modeled an airbag and attached it to a CRS model to protect the head and neck. The CRS airbag model was created by scaling the shape of the driver's airbag from the MADYMO database. The airbag's material properties were determined from the literature [7]. The airbag was attached to a rigid body, which was connected to the CRS cushion by a rigid joint. The airbag was located in front of the 3-year-old FE human model and along the trajectory of the head's center of gravity, which was acquired by pre-simulation. The airbag model and the CRS model with an airbag are shown in Figure 1.

3. Frontal Crash Simulation

A sled test with an ECE seat was simulated in this study. Numerical simulations employed the CRS and the child human model using the acceleration pulse acquired from the sled

CRS designs with the load limiter. The 5 CRS designs had different specified load limiter levels that ranged from 1600 N to 2400 N in 200 N increments. Figure 2, which compares the head resultant acceleration and chest deflection using these CRSs, shows that the more the load limiter level decreased, the more head resultant acceleration and chest deflection tended to decrease. Figure 3 compares the head trajectories. The more the load limiter level decreased, the more the maximum of head displacement increased.

Airbags are often considered dangerous for children due to their sudden, violent deployment. Since the airbag model may injure the child human model, the injury indexes may increase by using airbags. Therefore their influence must be investigated. We investigated the influence of this airbag on the injury indexes of the child human model by running crash simulations. Figure 4 compares the head resultant acceleration and neck bending between CRS models with and without airbags. From Figure 4(a), an oscillatory waveform

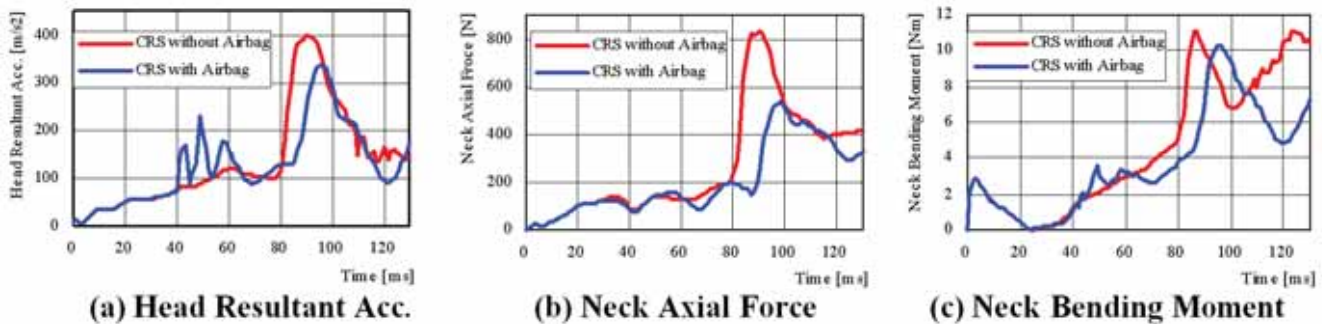


Fig. 4 - Response Comparison between CRS without/with Airbag

test. The supplied acceleration was compliant with ECE R44 [5]. A crash analysis code, MADYMO, was used. In numerical simulations, the belt release caused by a load limiter may change the behavior of the child human model. The value of the specified load may also influence the behavior. We investigated the influence of the load limiter on the child human model and conducted numerical simulations using the child human and CRS models with a load limiter. The standard load level was specified as 2000 N, which is half the general load limiter value for adult occupants. We compared the CRS design without the load limiter and the 5

was observed in the head resultant acceleration of CRS with airbag, because its vibration during deployment was transmitted to the child's head on contact. However, Figure 4 shows that the peak values of three injury values were reduced by using the airbag. Additionally, the time positions of these response peaks were delayed. The peak value of the neck axial force decreased the most.

4. Optimization of CRS Model

The optimal limit level of the load limiter depends on the size of the occupant and the severity of deceleration.



limiter, the airbag's vent hole size, and the airbag's x- and z-coordinates were set as design parameters.

4.1 Optimization Results

In the case of multiple objectives, a number of Pareto optimal designs exist for which a multi-objective algorithm can search and find. Pareto optimal designs are a set of designs with no other superior designs in all objectives.

Pareto optimal designs were obtained by optimization using RSM, which is an approximation method. We ran a set of crash simulations for the Pareto optimal designs. These design distributions obtained by RSM and the actual crash simulations are shown in Figure 5. The X-axis means HIC15, the Y-axis means the neck axial force, and the color of bubbles means the neck bending moment.

Additionally, the big light green circle is the original design, and the big blue one is the optimal design selected from the Pareto optimal designs. The figure indicates that multi-objective optimization simultaneously decreased three injury indexes.

5 Comparison between Original and Optimal Models

To investigate the effect of the optimization of the CRS model with the load limiter and airbag, we compared the original model without load limiter and without airbag to optimize the previously selected model. Table 1 summarizes the comparison of the peak response values between the original and the optimal models. Additionally, Figures 6 and 7 compare the response and behavior between both models. First, the responses of both models were compared and discussed. Table 1 indicates that all the peak response values decreased, especially the neck axial force, which decreased the most. Additionally, from Figure 6(b), the peak of the neck axial force in the original model disappeared in the optimal

	HIC15	Neck Axial Force [N]	Neck Bending Moment [Nm]
Original Model	127	828	12.2
Optimal Model	80	440	9.6

Table 1 - Comparison of Peak Value between Original Model and Optimal Model

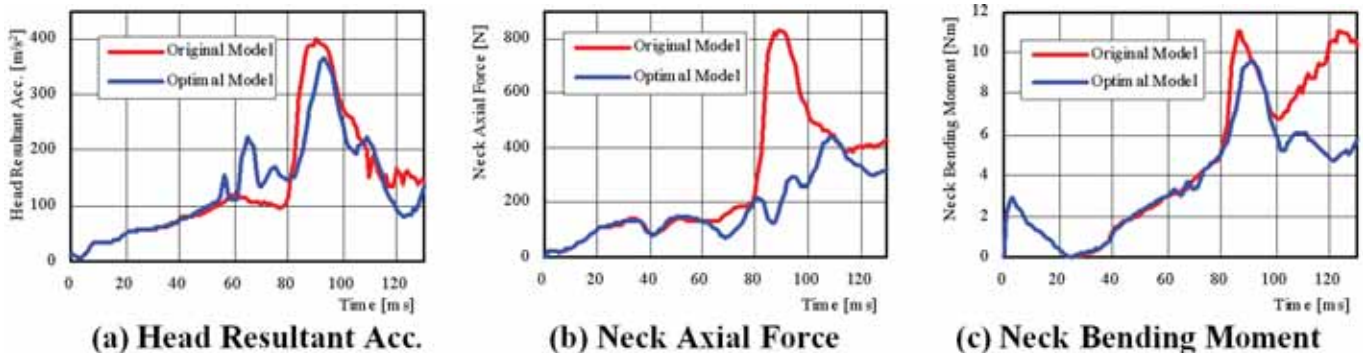


Fig. 7 - Response Comparison between Original and Optimal Models

Fig. 6 - Design Distribution of HIC15, Neck Axial Force, and Neck Bending Moment

Additionally, the size of the airbag's vent holes greatly influences the energy absorption performance. The airbag's location is also crucial for efficient energy absorption. The size of the vent holes and the airbag's location have optimal values. In this research, we performed an optimization of these values.

Generally, the optimization process needs a huge number of iterative calculations for assessment. However, assessing all optimization designs is unrealistic because the 3-year-old human model is computationally expensive, so we performed optimization with a combination of an optimization algorithm and RSM. More concretely, first a series of crash simulations were run based on a design of experiments (DOE), and then response surfaces of each objective function were created using the simulation results. Last, using these response surfaces, the optimization of the design parameters was performed with the optimization software modeFRONTIER. To create accurate response surfaces, a proper choice of sampling points i.e., DOE, is important. We used Central Composite Design (CCD), which is the most popular class of designs used for fitting the after-mentioned second order response surface model [8]. First, 25 simulations were run based on CCD. The level of the load



model. This may be because the airbag restrained the translational motion of the child's head, as shown in Figure 7. Figure 6(c) shows the increase of the neck bending moment after 100 ms in the original model were restrained in the optimal model.

This may be because the airbag restrained the rotational motion of the head and neck forward flexion, as shown in Figure 7 at 120 ms. Next, the behavior of both models was compared and discussed. No behavior differences were observed at 40 and 80 ms from Figure 7. At 120 ms, differences of neck flexion were observed, as mentioned above. Additionally, the airbag restrained the amount of head excursion, which generally causes injury to the head and face. For all these reasons, the optimization of the CRS model with a load limiter and an airbag might improve the crash safety of an actual CRS.

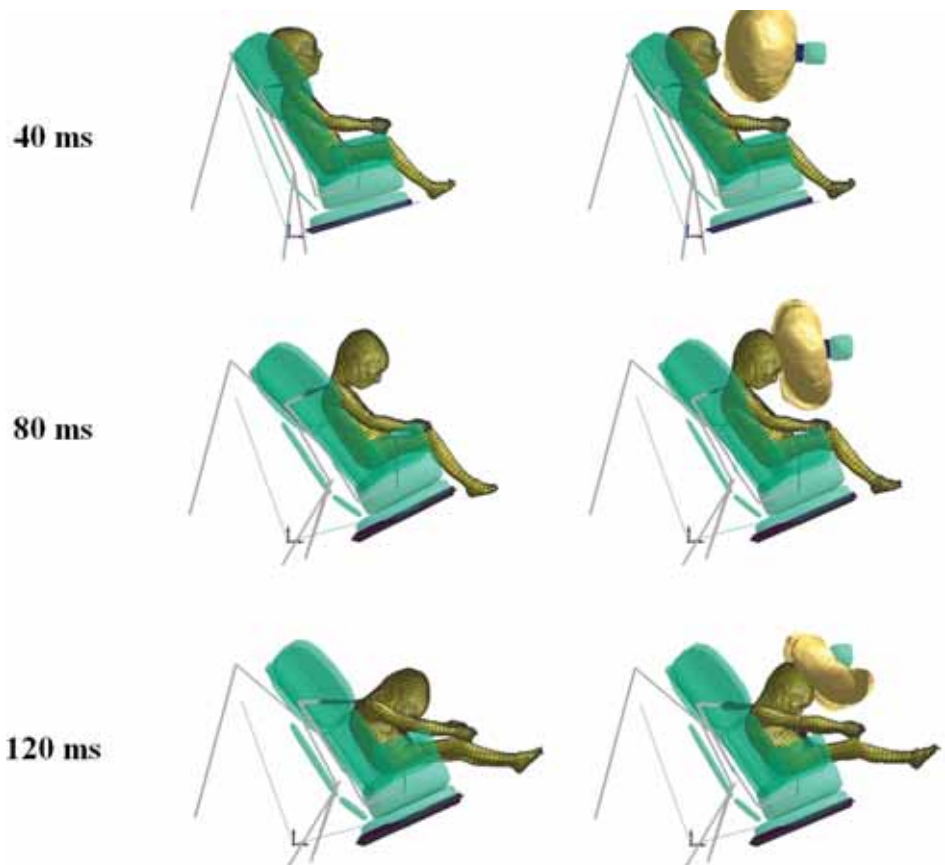


Fig. 7 - Comparison of behavior between Original and Optimal Models

6 Conclusions

The following conclusions were drawn from this study.

1. The numerical simulations showed that the load limiter reduced the head resultant acceleration and chest deflection and increased the head excursion of the child human model.
2. The numerical simulations showed that an airbag reduced HIC15, the neck axial force, and the neck bending moment.
3. Using a multi-objective optimization algorithm with RSM enables efficient and simultaneous optimization of three injury risks.
4. Multi-objective optimization with RSM of the CRS model using a 3-year-old human model shows the possibility of improving the crash safety of CRSs.

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By courtesy of ISMA 2008 International Conference on Noise and Vibration Engineering, an extended version of this article was presented at ISMA 2008, 16 September 2008 and published in the Conference Proceedings



Optimal reconstruction of a distribution

Optimal node positions for an adaptive algorithm used to reconstruct a distribution from a finite set of moments

Introduction

The reconstruction of a distribution knowing only a small number of its moments, the so-called “finite moment problem”, arises not only in chemical and process engineering but in many different fields of science (image processing, magnetic imaging, molecular physics...). Up to now there is no definitive method to solve this stiff ill-posed inverse problem.

The most efficient computational technique to describe disperse particulate flows relies presently on techniques such as method of moments, quadrature method of moments or direct quadrature method of moments (DQMOM). All these techniques yield the resulting particle distribution in terms of a limited number of moments. The inverse problem (reconstruction of the distribution) must then be solved.

Reconstructions using prescribed functions are very popular in practical chemical engineering applications, but require previous information on the shape of the distribution. Very often, this information is not available. The algorithm must then be able to reconstruct the distribution without any specific knowledge of the solution. A typical example is the reconstruction of Particle Size Distributions (PSD) when considering particulate processes like crystallization or precipitation (Fig.1 [1]), as done in this work.

A flexible algorithm proposed in John et al. [2] using splines for reconstructing the distribution requires no a priori information about the shape of the function and needs only a rough estimation of the domain, on which the distribution exists. Good results have been achieved with this method for reconstructing smooth functions. However, for more complex distributions the algorithm often fails to deliver a satisfactory result.

The equidistant grid used in this algorithm may not always allow resolving critical areas accurately. Exhaustive trial and error tests have shown that the position of the function nodes is a key factor to depict correctly the height, position and shape of the distribution peaks. A first version of an automatic, adaptive procedure has been recently developed as described in [3]. Nevertheless, an optimization might support an even improved fine-tuning of



Fig.1 –Spatial distribution of a selected mixing parameter, flow from left to right [1].

the automatic node re-distribution in future investigations. Therefore, an optimization based on varying the node positions has been performed using the genetic algorithm NSGA-II in modeFRONTIER.

Optimization Strategy and Results

The optimization procedure in modeFRONTIER is let free to explore a wide range of possible node positions. The objective of the optimization is to minimize the error of the moments obtained with the reconstructed distribution compared with a given known solution. The moment computation and the spline interpolation needed for a given set of control point positions are performed by Matlab. The software package modeFRONTIER has been easily coupled with Matlab and the NSGA-II algorithm can be finally applied to adjust the control points without any a-priori knowledge of the given solution.

Certainly, this kind of optimization can only be performed if the solution is already known in advance, which is normally not the case in practical applications! Nevertheless,



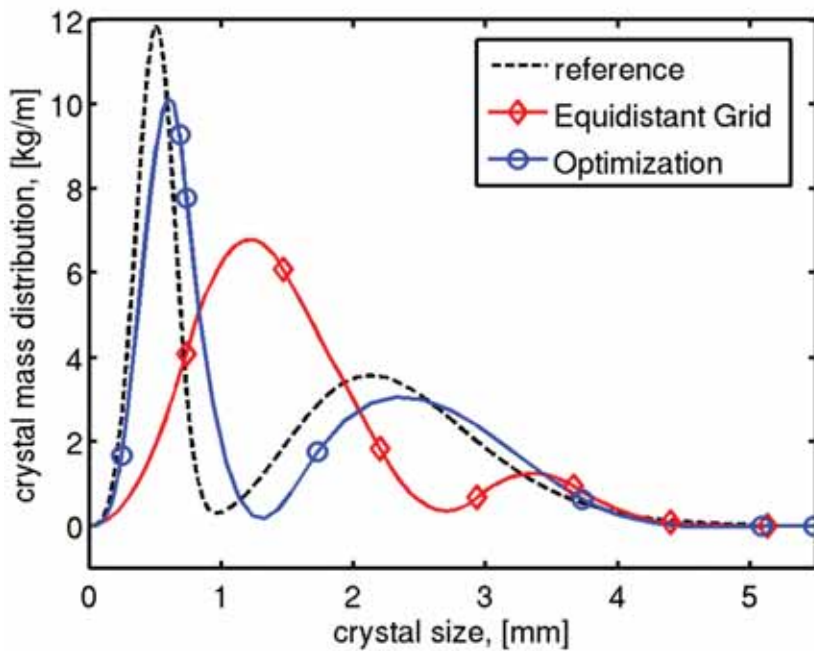


Fig.2 - Reconstruction of a smooth, two-peak distribution using four moments.

the analysis of the optimization results will lead to valuable information in order to develop general guidelines, how the node positions should be chosen for typical distributions. Therefore, these results support the development of an improved automatized procedure allowing an excellent re-distribution of the control points for the spline-based reconstruction method during run-time.

The graphs in Fig. 2 and Fig. 3 depict the reconstructions based on an equidistant grid (former method [2]) and optimal position of the nodes (as given by the procedure involving modeFRONTIER), respectively. It can be seen that the optimization has provided a much better description of the overall distribution and has also been able to resolve quite well critical areas, e.g., the very sharp and stiff decrease of the function at the end of the first peak (Fig. 3).

Summary

A flexible spline-based reconstruction technique has been developed to reconstruct a distribution when knowing only a small number of its moments. The original equi-distant distribution of the control points has been successfully extended with an automatic adaptive procedure. The presented optimization results have demonstrated that optimization may support the development of an even more efficient procedure for re-distributing the function

nodes. In this manner, the employed reconstruction algorithm can be improved.

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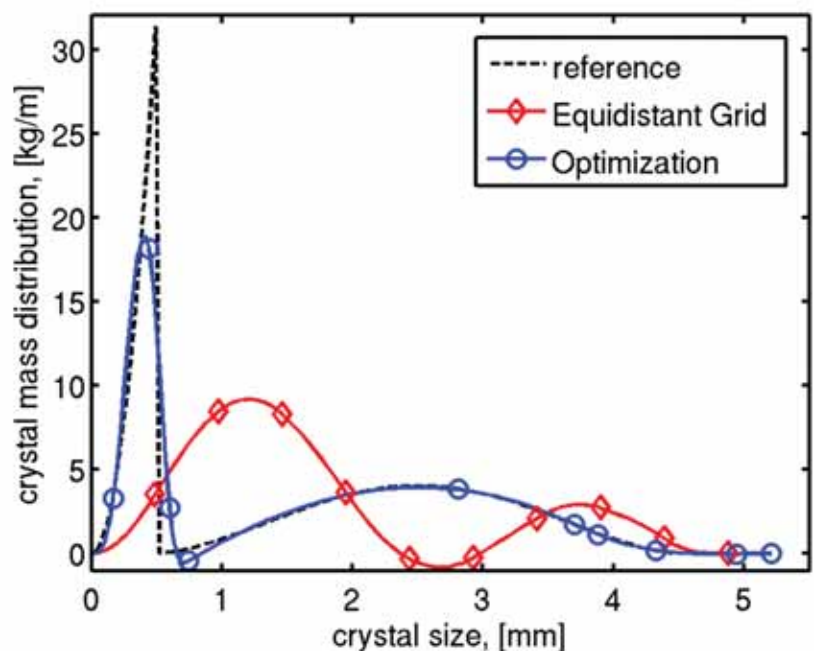


Fig.3 - Reconstruction of a non-smooth, two-peak distribution using seven moments.



Scilab Finite Element Solver for stationary and incompressible Navier-Stokes equations

Scilab is an open source software package for scientific and numerical computing developed and freely distributed by the Scilab Consortium



Scilab is an open source software package for scientific and numerical computing developed and freely distributed by the Scilab Consortium.

Scilab offers a high level programming language which allows the user to quickly implement his/her own applications in a smart way, without strong programming skills. Many toolboxes, developed by users all over the world and made available through the internet, represent real opportunities to create complex, efficient and multiplatform applications.

Scilab is regarded almost as a clone of the well-known MATLAB, actually, the two technologies have many points in common: the programming languages are very similar (despite some differences), they both use a compiled version of numerical libraries to make basic computations efficient, they offer nice graphical tools and more. In brief, they adopt the same philosophy, but Scilab is completely free.

Unfortunately, Scilab is not yet widely used in industrial areas where, on the contrary, MATLAB and MATLAB SIMULINK are the most known and frequently used. This is probably due to the historical advantage that MATLAB has over all the competitors. Launched to the markets in the late 70's, it was the first software of its kind. However, we have to recall that

MATLAB has many built-in functions that Scilab does not yet provide. In some cases, this could be determinant. While the number of Scilab users, their experiences and investments have grown steadily, the author of this article thinks that the need to satisfy a larger and more diverse market, also led to faster software developments in recent years. As in many other cases, also the marketing played a fundamental role in the diffusion of the product.

Scilab is mainly used for teaching purposes and, probably for this reason, it is often considered inadequate for the solution of real engineering problems. This is absolutely false, and in this article, we will demonstrate that it is possible to develop efficient and reliable solvers using Scilab, also for non trivial problems.

To this aim, we choose the Navier-Stokes equations to model a planar stationary and incompressible fluid motion. The numerical solution of such equations is actually considered a difficult and challenging task, as it can be seen reading [3] and [4], just to provide two references. If the user has a strong background in fluid dynamics, he/she can obviously implement more complex models than the one proposed in this document using the same Scilab platform.

Anyway, there are some industrial problems that can be adequately modeled using these equations: heat exchangers, boilers and more, just to name a few possible applications.

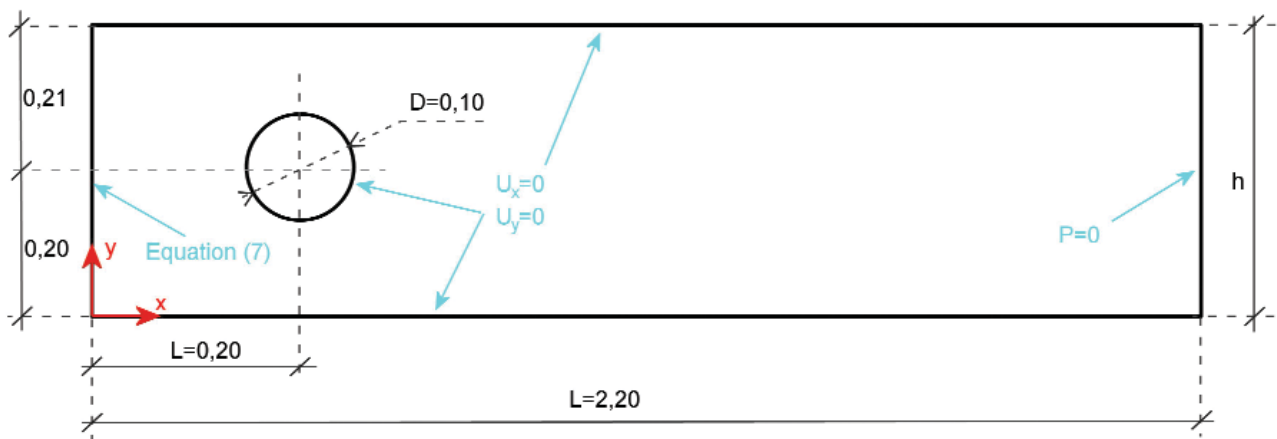


Fig. 2 - The benchmark problem of a laminar flow around a cylinder used to test our solver; the boundary conditions are drawn in blue. The same problem has been solved using different computational strategies in [6]; the interested reader is addressed to this reference for more details.



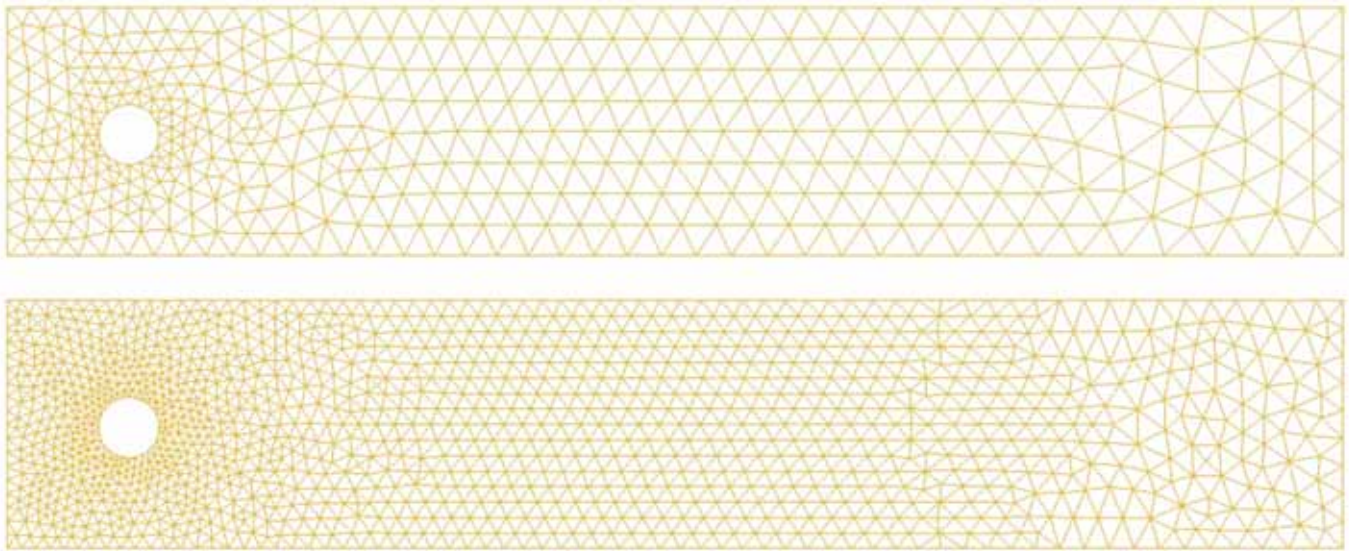


Fig. 3 - The two meshes used for the benchmark. On the top the coarse one (3486 unknowns) and on the bottom the finer one (11478 unknowns).

The Navier-Stokes equations for the incompressible fluid

Navier-Stokes equations can be derived applying the basic laws of mechanics, such as the conservation and the continuity principles, to a reference volume of fluid (see [2] for more details). After some mathematical manipulation, the user usually reaches the following system of equations:

$$\begin{cases} \nabla \cdot \mathbf{U} = 0 \\ -\nabla \cdot (\mu \nabla \mathbf{U}) + \rho \mathbf{U} \nabla \mathbf{U} + \nabla P = 0 \\ -\nabla \cdot (k \nabla T) + \rho c \mathbf{U} \nabla T = 0 \end{cases} \quad \text{in } \Omega \quad (1)$$

which are known as the continuity, the momentum and the energy equation respectively. They have to be solved in the domain Ω , taking into account appropriate boundary conditions. The symbols " $\nabla \cdot$ " and " ∇ " are used to indicate the divergence and the gradient operator respectively, while \mathbf{U} , P and T are the unknown velocity vectors, the pressure and the temperature fields. The fluid properties are the density ρ , the viscosity μ , the thermal conductivity k and the specific heat c which could depend generally speaking on temperature.

We have to remember that in the most general case equations, such as explained in (1), other terms such as heat sources or body forces could be involved, which we have neglected in the present case.

For sake of simplicity we imagine all the fluid properties as constant and we will consider, as mentioned before, only two dimensional domains. The former hypothesis represents a very important simplification because the energy equations completely decouple and therefore, it can be solved separately once the velocity field has been computed using the first two equations. The latter one can be easily removed, with some additional effort in programming.

A source of difficulty is given by the first equation in (1), which represents the incompressibility constraint. In order to satisfy the inf-sup condition (also known as Babuska-Brezzi condition) we decide to use the six-noded triangular elements; the velocity field is modeled using quadratic shape

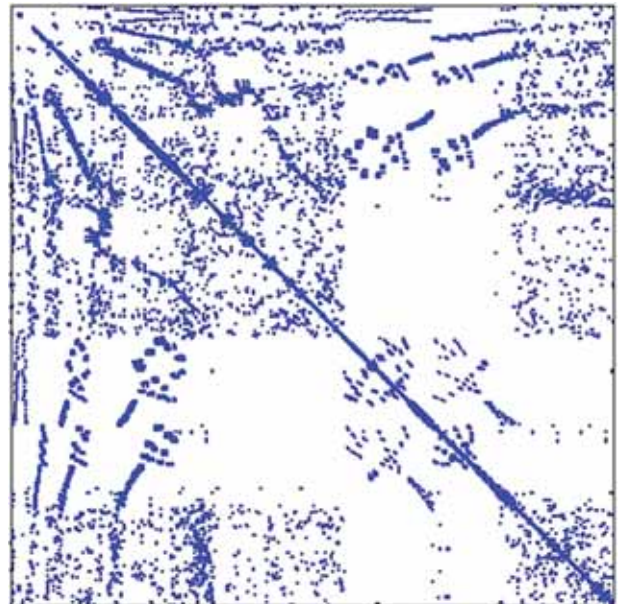


Fig. 4 - The sparsity pattern of the system of linear equations that have to be solved each iteration for the solution of the first model of the channel benchmark (3486 unknowns) is drawn. It has to be noted that the pattern is symmetric with respect to the diagonal, but unfortunately the matrix is not. The non-zero terms amount to 60294, leading to a storage requirement of $60294 \times (8 + 2 \times 4) = 965$ Kbytes, if a double precision arithmetic is used. If a full square matrix were used, $3486 \times 3486 \times 8 = 97217568$ Kbytes would be necessary!

functions and two unknowns at each node are considered, while the pressure is modeled using linear shape functions and only three unknowns are used at the corner nodes.

For the solution of the equations reported in (1) we decide to use a traditional Galerkin weighted residual approach, which is not ideally suitable for convection dominated problems: it is actually known that when the so-called Peclet number (which expresses the ratio between convective and diffusion contributions) grows, the computed solution suffers from a non-physical oscillatory behavior (see [2] for details). The same problem appears when dealing with the energy equation (the third one in (1)), whenever the convective contribution is sufficiently high.



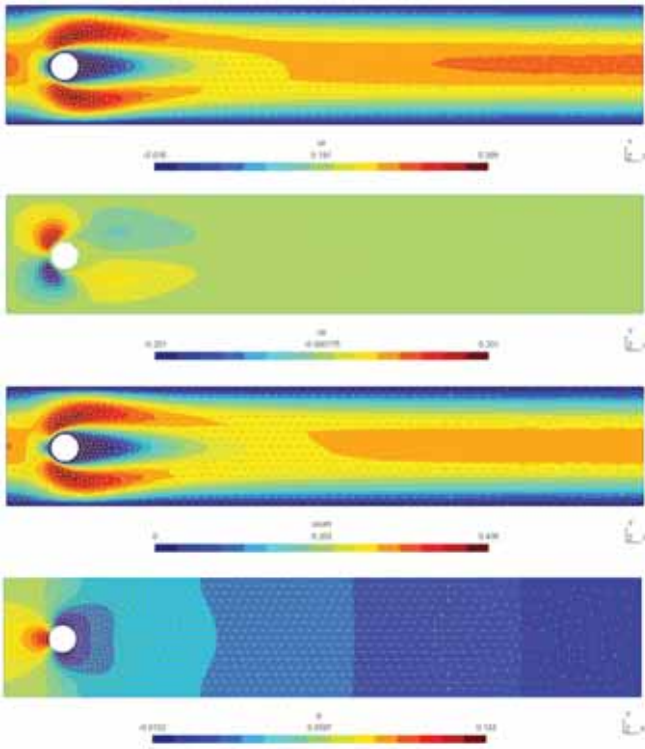


Fig. 5 - Starting from top, the x and y components of velocity, the velocity magnitude and the pressure for Reynolds number equal to 20, computed with the finer mesh.

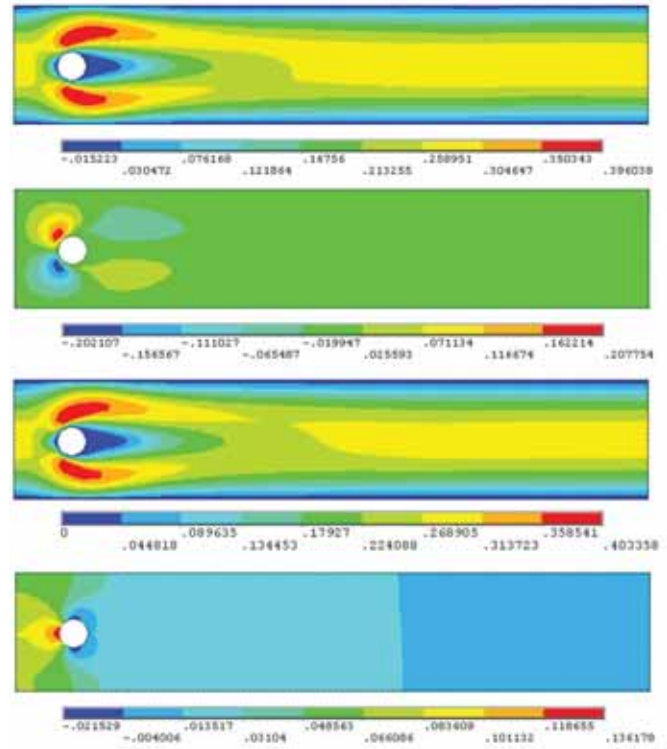


Fig. 6 - Starting from top, the x and y components of velocity, the velocity magnitude and the pressure for Reynolds number equal to 20, computed with the ANSYS-Flotran solver (2375 elements, 2523 nodes).

This phenomenon can uniquely be ascribed to some deficiency of the numerical technique. For this reason, many workarounds have been proposed to correctly deal with convection dominated problems. The most known are surely the streamline upwinding schemes, the Petrov-Galerkin, least square Galerkin approaches and other stabilization techniques. In this work, we do not adopt any of these techniques, knowing that the computed solution with a pure Galerkin approach will be reliable only in the case of diffusion dominated problems. As already mentioned, it could be in principle possible to implement whatever technique to improve the code and to make the solution process less sensitive to the flow nature, but this is not the objective of this work.

It is fundamental to note that the momentum equation is non-linear due to the presence of the advection term $\rho U U$. The solution strategy adopted to deal with this nonlinearity is probably the simplest one and it is usually known as the recursive approach (or Picard approach).

An initial guess for the velocity field has to be provided and a first system of linear equations can be assembled and solved. Once the linear system has been solved the new computed velocity field can be compared with the guess field: if no significant differences are found, the solution

process can be stopped. Otherwise a new iteration has to be performed using the new velocity field just computed as the guess field.

This process usually leads to the solution within a reasonable amount of iterations, and it has the advantage that it can be very easily implemented. For sure, there are more effective techniques, such as, for example the Newton-Raphson scheme, but they usually require to compute the Jacobian of the system hence more time for their implementation will be needed.

Laminar flow around a cylinder

In order to test the solver just written with Scilab, we decided to solve a simple problem which has been used by different authors (see [3], [6] for example) as a benchmark problem to test different numerical approaches for the solution of incompressible, steady and unsteady, Navier-Stokes equations. In Figure 2

the problem is drawn, where the geometry and the boundary conditions can be found. The fluid density is set to 1 and the viscosity to 10^{-3} . A parabolic (Poiseuille) velocity field in x direction is imposed on the inlet, as shown in equation (2),

$$\begin{cases} U_x(y) = \frac{4U_m y(h-y)}{h^2} \\ U_y(y) = 0 \end{cases} \quad (2)$$

with $U_m=0.3$, a zero pressure condition is imposed on the outlet. The velocity in both directions is imposed to be zero on the other boundaries. The Reynolds number is computed

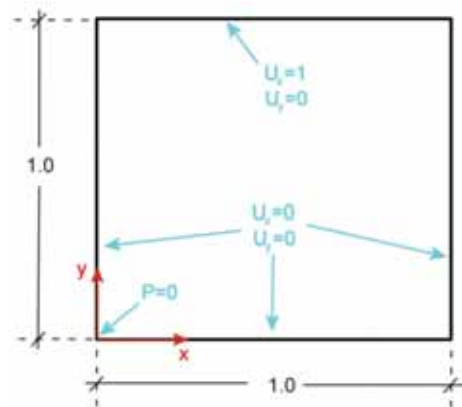


Fig. 7 - The geometry and the boundary conditions of the second benchmark used to test the solver.



Reynolds Number	Author	x	y
100	Solver proposed in [3]	0.62	0.74
	Burggraf (1996)	0.62	0.74
	Tuann and Olson (1978)	0.61	0.722
	Scilab solver	0.617	0.736
400	Solver proposed in [3]	0.568	0.606
	Burggraf (1996)	0.560	0.620
	Tuann and Olson (1978)	0.506	0.583
	Ozawa (1975)	0.559	0.614
	Scilab solver	0.558	0.606
1000	Solver proposed in [3]	0.540	0.573
	Ozawa (1975)	0.533	0.569
	Goda (1979)	0.538	0.575
	Scilab solver	0.534	0.569

Table 1 - The results collected in [3] have been reported here and compared with the analogous quantities computed with our solver (Scilab solver). A satisfactory agreement is observed.

as $Re = (\bar{U} D) / \nu$, where the mean velocity at the inlet $\bar{U} = (2U_m) / 3$, the circle diameter D and the kinematic viscosity $\nu = \mu / \rho$ have been used.

In Figure 3 the adopted meshes have been drawn. The first has 809 elements, 1729 nodes, totally 3486 unknowns while the second has 2609 elements, 5409 nodes, totally 11478 unknowns.

The computations can be performed on a common laptop pc. In our case, the user has to wait around 43 [sec] to solve the first mesh, while the total solution time is around 310 [sec] for the second model; in both cases 17 iterations are necessary to reach convergence. The larger part of the solution time is spent to compute the element contributions and fill the matrix: this is mainly due to the fact that the system solution invokes the taucs, a compiled library, while the matrix fill-in is done directly in Scilab which is interpreted, and not compiled, leading to a less performing run time.

The whole solution time is however always acceptable, even for the finest mesh.

The same problem has been solved with ANSYS-Flotran (2375 elements, 2523 nodes) and results can be compared with the ones provided by our solver. The comparison is encouraging because the global behavior is well captured also with the coarser mesh. Moreover, the numerical differences registered between the maximum and minimum values are always acceptable, considering that different grids are used by the solvers.

Other two quantities have been computed and compared with the analogous quantities proposed in [6]. The first one is the recirculation length which is the region behind the circle where the velocity along x is not positive, whose expected value is between 0.0842 and 0.0852; the coarser mesh provides a value of 0.0836 and the finer one a value of 0.0846. The second quantity which can be

compared is the pressure drop across the circle, computed as the difference between the pressures in (0.15; 0.20) and (0.25; 0.20); the expected value should fall between 0.1172 and 0.1176. In our case, the coarser mesh gives 0.1191 while the finer gives 0.1177.

The cavity flow problem

A second standard benchmark for incompressible flow is considered in this section. It is the flow of an isothermal fluid in a square cavity with unit sides, as schematically represented in Figure 7; the velocity field has been set to zero along all the boundaries, except for the upper one, where a uniform unitary horizontal velocity has been imposed. In order to make the problem solvable a zero pressure has been imposed to the lower left corner of the cavity.

We would like to guide the interested reader to [3], where the same benchmark problem has been solved. Some comparisons between the position of the main vortex obtained with our solver and the analogous quantity computed by different authors and collected in [3] have been done and summarized in Table 1. In Figure 8 the velocity vector (top) and magnitude (bottom) are plotted for three different cases; the Reynolds number is computed as the inverse of the kinematic viscosity, being the reference length, the fluid density and the velocity all set to one. As the Reynolds number grows, the center of the main vortex tends to move through the center of cavity.

Thermo-fluid simulation of a heat exchanger

The solver has been tested and it has been verified that it provides accurate results for low Reynolds numbers. A new problem, may be more interesting from an engineering point of view, has been considered: let us imagine that a warm water flow (density of 1000 [Kg/m³], viscosity of 5·10⁻⁴ [Pa·s], thermal conductivity 0.6 [W/m·°C] and specific heat 4186

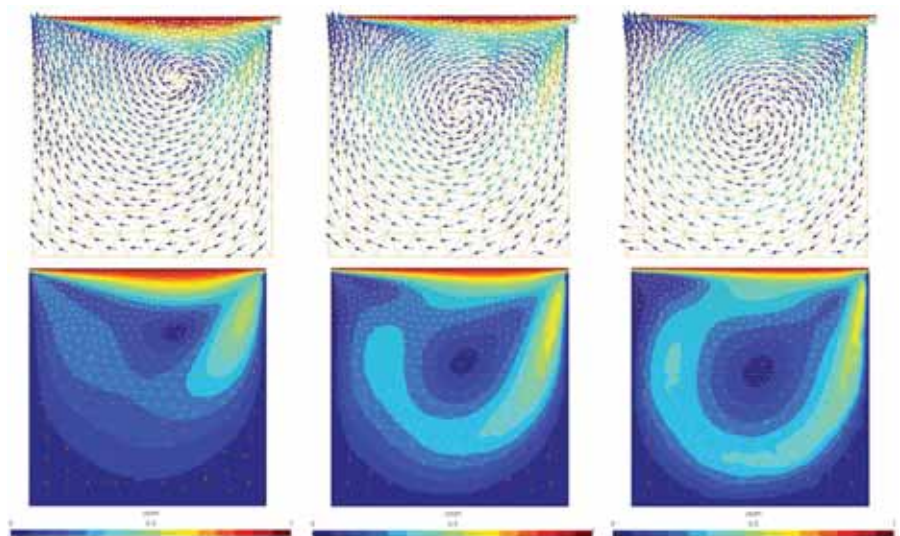


Fig. 8 - The velocity vector (top) and the velocity magnitude (bottom) plotted superimposed to the mesh for Re=100 (left), for Re=400 (center) and for Re=1000 (right). The main vortex tends to the center of the cavity as the Reynolds numbers grows and secondary vortexes appear.



[J/Kg°C]) with a given velocity enters into a sort of heat exchanger where some hot circles are present. We would like to compute the outlet fluid temperature imagining that the flow is sufficiently low to allow a pure Galerkin approach.

In Figure 9 the mesh for this model is drawn, together with some dimensioning: we decided to consider only the upper part of this heat exchanger in view of the symmetry with respect to the x-axis. The mesh contains 10673 nodes, leading to 22587 velocities and pressures nodal unknowns and 10302 nodal temperatures unknowns.

The symmetry conditions are simply given by imposing homogeneous vertical velocity and thermal flux on the boundaries lying on the symmetry axis. The horizontal inlet velocity follows a parabolic law which goes to zero on the boundary and assumes a maximum value of $1 \cdot 10^{-3}$ [m/s] on the symmetry axis. The inlet temperature is 20 [°C] and the temperature of the circle surfaces has been set to 50 [°C]. The outlet pressure has been set to zero in order to get a unique solution.

As explained above, the velocity and pressure fields can be computed first, and then the energy equation can be tackled in a second phase to compute the temperature in each point.

In Figure 10 the fluid velocity magnitude and in Figure 11 the temperature field are drawn.



Fig. 9 - The heat exchanger considered in this work. The symmetry axis is highlighted in blue and some dimensioning (in [cm]) is reported.

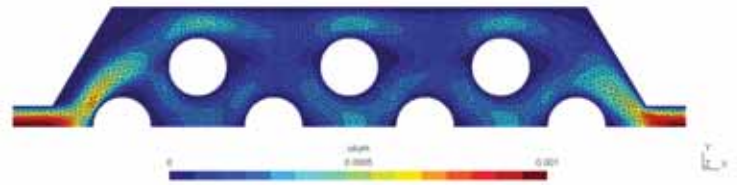


Fig. 10 - The velocity magnitude plotted superimposed to the mesh.

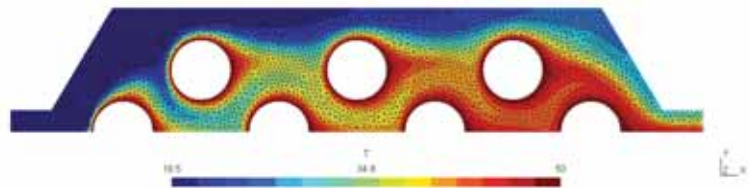


Fig. 11 - The temperature field. It can be seen that the inlet temperature is 20 [°C], the circles temperature is 50 [°C], while the outlet temperature vary from a minimum of 32.60 [°C] up to a maximum of 44.58 [°C].

Navier-Stokes equations, for the incompressible and stationary flow, has been implemented using the standard tools provided in Scilab. Three examples have been presented, and some comparisons with results provided by commercial software and available in literature, have been performed in order to test the solver.

It is worth mentioning that obviously a certain background in finite element analysis is mandatory, but no advanced programming skills are necessary to implement the solver.

Conclusions

In this work we have shown how to use Scilab to solve complex problems in an efficient manner. In order to convince the reader that this is feasible, a solver for the

About Scilab and EnginSoft

Scilab is a free open source software with a GPL compatible licence EnginSoft France supports the Scilab Consortium as a member from industry with a strong background in R&D and educational initiatives for CAE. Based in Rocquencourt, near Versailles/ Paris, the Scilab Consortium currently includes 19 members (both industrials and academics). Scilab's Research and Development Team implements the development and promotional policies decided by the Consortium.

Over the years, contributions have been numerous on projects such as gfortran, matio, lapack, hdf5, jhdf, jgraphx, autoconf, automake, libtool, coin-or, getfem, indefero, kdbg, OpenMPI, Launchpad...

The Scilab Consortium R&D Team also collaborates with many packagers of GNU/Linux, Unix and BSD distributions (Debian, Ubuntu, Mandriva, Gentoo, Redhat, Fedora, OpenSolaris...) in order to help them to provide Scilab in their distributions in the best possible way.

To communicate with Scilab, and for more information, please visit: www.scilab.org

References

- [1] <http://www.scilab.org/> to have more information on Scilab.
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- [6] M. Schafer, S. Turek, Benchmark Computations of laminar Flow Around a Cylinder, downloaded from <http://www.mathematik.uni-dortmund.de/de/personen/person/Stefan+Turek.html>.

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L'ingegner Paci testimonial del successo delle tecnologie CAE in Perini Navi

Perini Navi nasce nei primi Anni Ottanta con l'obiettivo di creare velieri di grandi dimensioni manovrabili da una sola persona. Oggi il rivoluzionario sistema per l'automazione del controllo del piano velico creato in quegli anni da Fabio Perini è diventato lo stato dell'arte della tecnologia della navigazione a vela e uno standard per l'intera cantieristica mondiale. Perini Navi è attualmente l'unico cantiere al mondo che progetta, sviluppa e quindi costruisce le proprie imbarcazioni.

Nella cornice di alberi velieri di 50 m e oltre in costruzione e di aggressivi profili di scafi di grandi dimensioni intervistiamo l'ing. Matteo Paci in Perini dal 2002 ed oggi Responsabile dell'ufficio tecnico Reparto alberi della Perini Navi.



Ing. Matteo Paci - Foto Credit Giuliano Sargentini



ProdAZ - - Foto Credit Giuliano Sargentini

1. Che spazio ha (e dovrebbe avere) l'innovazione nel mondo industriale/impresariale?

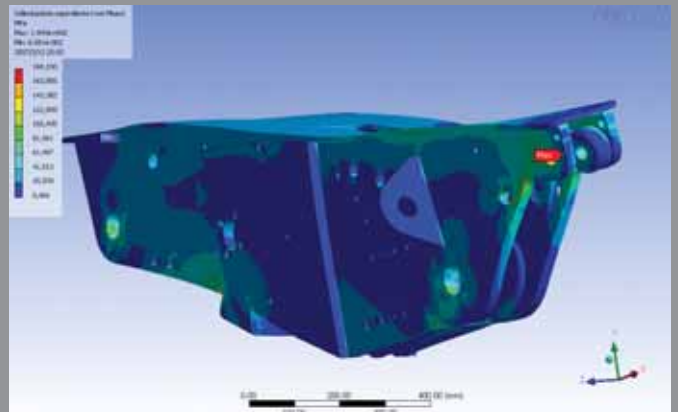
R1. In generale penso che l'innovazione debba avere uno spazio molto importante nel mondo dell'industria senza distinzioni tra i vari rami di prodotti specifici dato che, in qualsiasi campo essa sia applicata, tenda logicamente ad un miglioramento del prodotto in ogni particolare dettaglio.

I risultati portati dall'innovazione sono spesso il presupposto al miglioramento tecnico del prodotto sia dal punto di vista produttivo che di generale risparmio dei costi.

Ovviamente per ottenere i vantaggi legati all'innovazione, che personalmente ritengo attività mirata di R&D da svolgersi con tecnologie di avanguardia, è necessario programmare l'investimento in termini economici e di risorse umane e questo passaggio è strettamente legato alla mentalità innovativa presente all'interno delle singole realtà industriali.

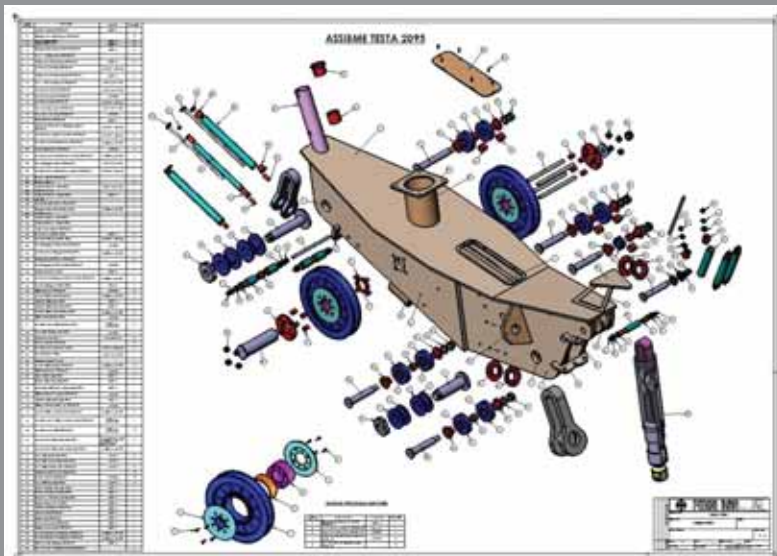
Registro che attualmente in Italia gli studi di innovazione appartengano ancora solo a settori industriali storicamente di punta quali aeronautica e automotive, mentre essa dovrebbe essere estesa anche a realtà più piccole, magari con investimenti più contenuti, ma che comunque possa determinare miglioramenti tecnici e di conseguenza accrescere il valore del prodotto nella attuale competitività sul mercato.

Nella realtà della nautica l'innovazione è ancora a un livello molto basso, dato che sono ancora l'esperienza e la tradizione ad ordinare la progettazione nel maggior numero dei casi; le poche realtà industriali nautiche che investono sull'innovazione sono di solito a scopo racing (vedi coppa america o imbarcazioni a motore da competizione).



Testa FEM





Testa Disegno

Fortunatamente nella nostra azienda abbiamo intrapreso un cammino innovativo ormai da già 5 anni con investimenti su software e nuovi materiali che ci sta portando a forti miglioramenti del prodotto.

Infine è mio profondo convincimento che il futuro sia caratterizzato da un accrescimento degli investimenti nel campo industriale, poiché sono sotto gli occhi di tutti i vantaggi conseguiti dalle aziende nautiche che hanno avuto il coraggio di investire in innovazione.

2. Dalle parole entusiastiche della sua risposta mi è naturale chiederle: in efficienza progettuale sulla produttività e in termini di ottimizzazione del Roi, quanto ha ad oggi inciso l'uso della simulazione virtuale?

I dati di riferimento si sintetizzano facilmente rivisitando alcuni aspetti degli ultimi progetti di alberi velici. In generale il peso dell'albero è diminuito del 30% in ragione della confidenzialità nell'adottare certe soluzioni progettuali indotte dall'uso della simulazione; tale conclusione determina conseguentemente alcuni vantaggi che rigorosamente riassumo:

- Aumento della prestazione velica;
- Risparmio economico sul costo materiali;
- Risparmio sui costi di produzione per esempi nelle operazioni di saldatura minori riempimenti dei cianfrini di saldatura;
- Risparmio di movimentazione inteso come operazioni programmatiche per issamento dell'albero stesso (meno pesante);
- Risparmio di trasporto;
- Maggiore sicurezza attraverso l'utilizzo i materiali più leggeri e meno carpenteria.

3. Ritornando ai termini generali: Quali sono le strategie per essere innovativi e quali valutazioni spingono all'innovazione?

Non esistono delle strategia particolari per essere innovativi. A mio parere devono aziendalimente coesistere grande volon-

tà e umiltà tese ad approfondire tecnicamente il prodotto aziendale al fine di individuarne gli aspetti migliorabili;

Tali atteggiamenti devono necessariamente accompagnarsi alla dotazione di mezzi idonei ad analizzare il prodotto e le problematiche specifiche di ogni industria.

È anche vero che alcune volte l'innovazione può avvenire anche da una originale intuizione, ma in generale il miglioramento e l'innovazione del prodotto sono realmente il traguardo di un processo logico e scientifico.

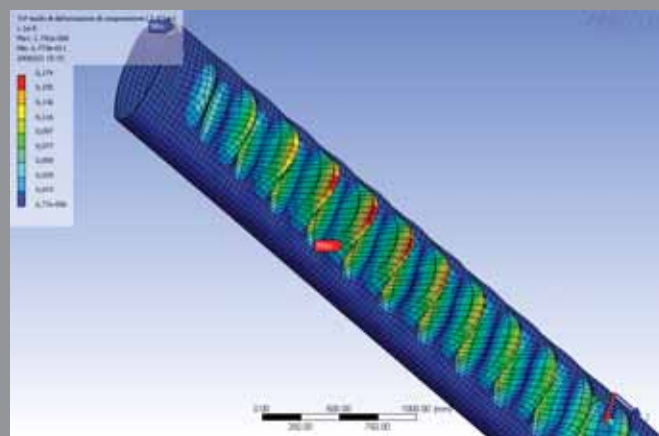
La valutazione che spinge all'innovazione spesso nasce dalla consapevolezza di produrre qualcosa di ormai obsoleto ed essa da sola non è sufficiente a essere la motivazione ad istituire un processo di innovazione meglio accontentarsi mai delle mete raggiunte dal proprio prodotto ed avere nel proprio DNA aziendale la determinazione a continuare sempre a studiare soluzioni nuove.



Testa PROD - - Foto Credit Giuliano Sargentini

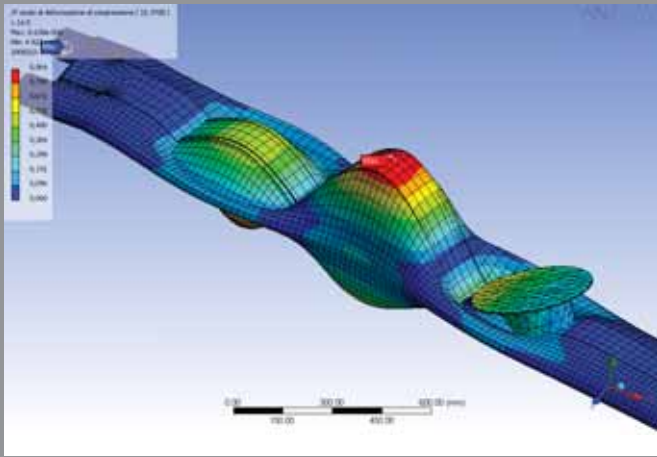
4. Che ruolo ricoprono gli strumenti CAE e di prototipazione virtuale in tal senso?

Essi ricoprono assolutamente un ruolo fondamentale che permette appunto di analizzare le tematiche tecniche in manie-



Groccetta modo collasso



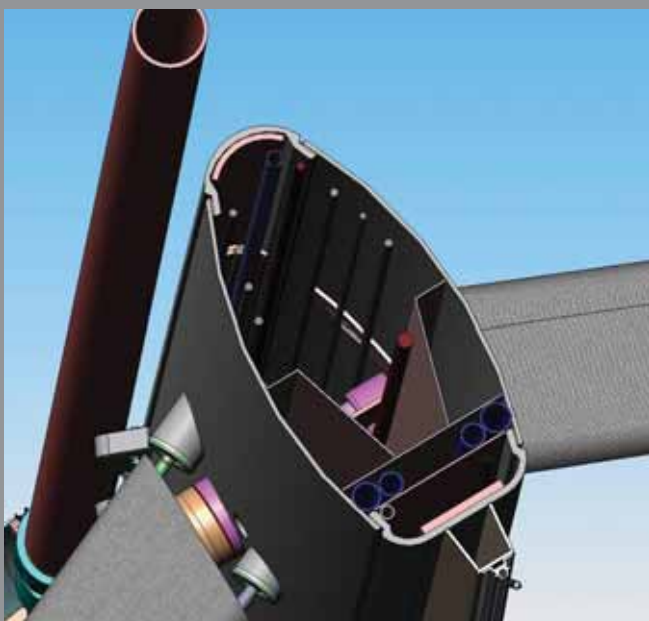


Crocetta modo collasso

ra molto più approfondita rispetto al passato, senza tener conto del risparmio economico portato dalla simulazione virtuale in aziende che basavano in passato tutta la prototipazione esclusivamente su prove sperimentali. Ovviamente è necessario valutare in maniera adeguata il livello di investimento economico negli strumenti di simulazione in relazione al costo finale del prodotto.

5. Quali vantaggi ha rilevato nella sua esperienza professionale e come è cambiato il suo approccio alla progettazione/produzione?

Nel campo della progettazione di sistemi velici per imbarcazioni di grosse dimensioni (superiori ai 40mt), abbiamo rilevato dei vantaggi enormi nell'uso della simulazione virtuale, a partire dai cad3d parametrici fino agli studi strutturali ad elementi finiti che ci hanno portato ad una diminuzione del peso finale del prodotto fino anche del 30% con conseguente risparmio economico e aumento delle prestazioni delle imbarcazioni. Di conseguenza anche la produzione è risultata più semplice e più veloce dovendo gestire materie prime, tipo lamiere, molto più leggere. Ovviamente l'approccio alla progettazione è cambiato drasticamente dato che adesso sia-



Alberto Disegno

mo in grado di spingerci ad analisi sia geometriche che strutturali molto dettagliate e potere anche analizzare diverse soluzioni in maniera molto più veloce e spesso anche più intuitiva.

6. Qual è stato il contributo di EnginSoft e in che modo ha saputo valorizzare qualità, potenzialità e capacità della sua industria/impresa?

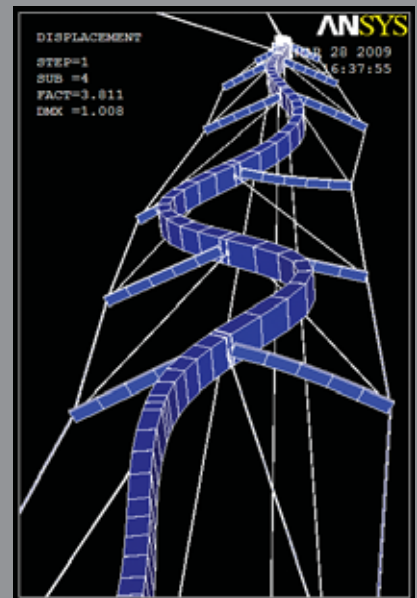
EnginSoft ha dato un grosso contributo alla valorizzazione del nostro prodotto grazie alla cooperazione più volte sperimentata su varie tematiche progettuali.

7. Che prospettive intravede per i codici di calcolo in relazione alle sfide poste dal futuro?

Penso che ci siano grandi prospettive per i codici di calcolo nel futuro, e questo grazie al sempre più diffuso utilizzo della simulazione virtuale nelle varie aziende e anche grazie alle richieste e aspettative manifestate dai clienti che stimolano appunto i programmatori e ricercatori ad una costante migrazione degli strumenti di simulazione virtuale.

8. Quali progetti, obiettivi e nuovi traguardi intende perseguire grazie all'uso di questi strumenti?

Nel nostro campo in particolare ci auspichiamo di poter facilmente analizzare in futuro i comportamenti post-buckling delle strutture e potere utilizzare in maniera rapida e intuitiva codici numerici che possano accoppiare studi aerodinamici a deformazioni strutturali.



Buckling Albero Vellico

Sicuramente l'obiettivo più importante, e al tempo stesso anche più difficile da raggiungere, sarebbe la realizzazione di codici che possano permettere la simulazione in real time della dinamica di una grossa imbarcazione a vela in termini di carichi e manovre che possa essere accoppiata ad un reale postazione di simulazione.

9. E cosa si auspica per il mondo della tecnologia scientifica alla continua ricerca di una dimensione tra creatività e competitività?

Spero che il modo della tecnologia continui a progredire come ha fatto negli ultimi anni, ovviamente lo stimolo alle nuove ricerche deve essere supportato soprattutto da aziende che abbiano la mentalità tesa all'innovazione e al progresso. Un'azienda che non investe nella ricerca e nella tecnologia scientifica può ritenersi un'azienda senza futuro. Senza ombra di dubbio la creatività e la ricerca portano a risultati certi di competitività e successo.



ANSYS Composite PrepPost: il salto evolutivo nella progettazione e nell'analisi delle strutture in materiale composito

Tra le novità introdotte nella versione 12.1, l'ambiente di analisi ANSYS Composite PrepPost – ACP – rappresenta una pietra miliare nell'evoluzione degli strumenti software di supporto alla progettazione ed alla prototipazione dei prodotti realizzati in materiale composito.

ACP rivoluziona definitivamente il processo di progettazione avanzata ed analisi agli elementi finiti delle strutture in materiale composito, integrando coerentemente all'interno di un'interfaccia intuitiva e funzionale tutte le informazioni necessarie alla previsione accurata delle prestazioni in esercizio, a partire dagli effetti del processo produttivo fino alla comparazione immediata dei failure criteria di ultima generazione. ANSYS Composite PrepPost fornisce in un unico ambiente tutte le funzionalità necessarie all'analisi ed all'investigazione approfondita del comportamento strutturale dei manufatti in materiale composito.

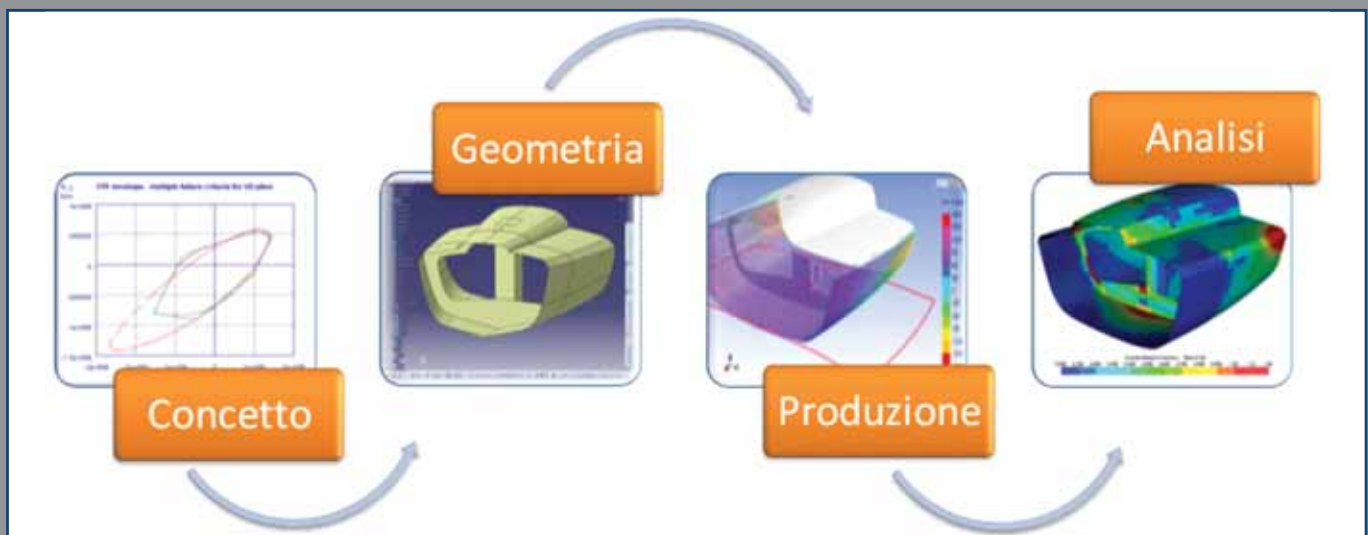
Una premessa fondamentale per introdurre sul mercato uno strumento innovativo consiste nel superare definitivamente i problemi collegati ai limiti riconosciuti alle precedenti versioni o ai principali concorrenti, senza che questo si ripercuota sull'accessibilità di utilizzo: l'adozione di strumenti basati sul metodo agli elementi finiti per la previsione prestazionale di strutture in composito si è finora scontrata con assunzioni non accurate (es. proprietà meccaniche teoriche dei materiali costituenti, failure criteria non rappresentativi dello stato dell'arte), o troppo

semplificative (es. direzioni ipotetiche delle fibre nelle singole lamine, assenza di effetti produttivi) oppure con la necessità di trafilare di strumenti esclusivi e disomogenei.

ANSYS Composite PrepPost supera i limiti riconosciuti dagli utenti FEM che operano nel settore dei materiali compositi in tutte le fasi di gestione delle informazioni specifiche applicate al modello matematico di analisi e sfrutta le potenzialità dell'integrazione dell'ambiente Workbench con i principali CAD disponibili sul mercato, divenendo lo strumento di riferimento per un'effettiva progettazione integrata.

Le logiche di sviluppo dei componenti e dei prodotti, i processi produttivi ed i problemi ad essi correlati, le informazioni tipiche dei fornitori dei materiali ed i concetti di definizione delle configurazioni candidate costituiscono i principi base del nuovo processo ingegneristico di prototipazione virtuale definito da ACP.

La definizione delle proprietà meccaniche dei materiali è disponibile secondo informazioni provenienti da database industriali ed impiegando concetti propri dei fornitori, l'importazione diretta dei principali formati CAD proprietari, la generazione automatica di modelli solidi a partire da modelli 2D, l'analisi degli effetti produttivi in termini di verifica della distorsione e della sovrapposizione delle pelli, la capacità di previsione del flat wrap ed il calcolo puntuale dell'angolo corretto di stesura delle fibre rispetto al valore

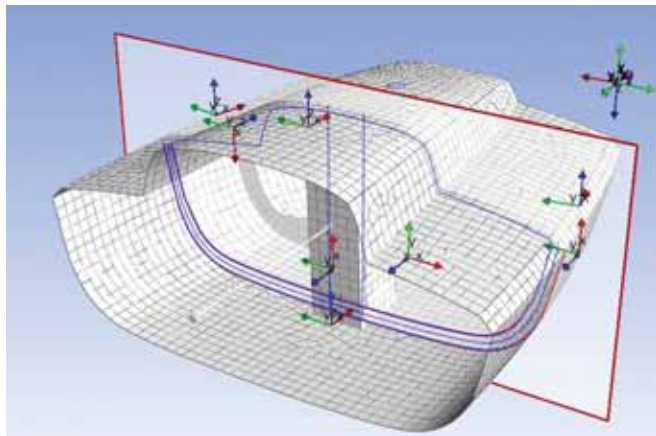


teorico, il concetto per la definizione dell'orientazione dei materiali indipendente dalla normale delle superfici, la visualizzazione delle singole lamine e degli spessori presenti sul modello tridimensionale, l'accuratezza numerica del solutore ANSYS, la disponibilità di failure criteria elementari o rappresentativi dello stato dell'arte come LaRC o Puck, il post processing dei risultati intuitivo, efficiente e completo, la possibilità di individuare immediatamente la regione critica visualizzando contemporaneamente sul modello 3D diversi failure criteria rispetto a differenti carichi applicati a livello di lamina o di laminato e la generazione automatica del ply book sono solo alcune delle novità sostanziali introdotte da ANSYS Composite PrepPost nel processo di progettazione. Esse, nel designarlo strumento di riferimento del settore, permettono all'utente di definire rapidamente configurazioni di laminati, di verificare problemi produttivi, di indicare interventi per incrementare l'efficacia di processo, di generare un modello numerico esatto ed accurato, di analizzare approfonditamente la risposta strutturale del sistema identificando univocamente le ragioni per cui potrebbe fallire, di investigare automaticamente ed efficientemente soluzioni che tengano conto di modifiche geometriche e meccaniche.

ANSYS® Composite PrepPost Product Features

General

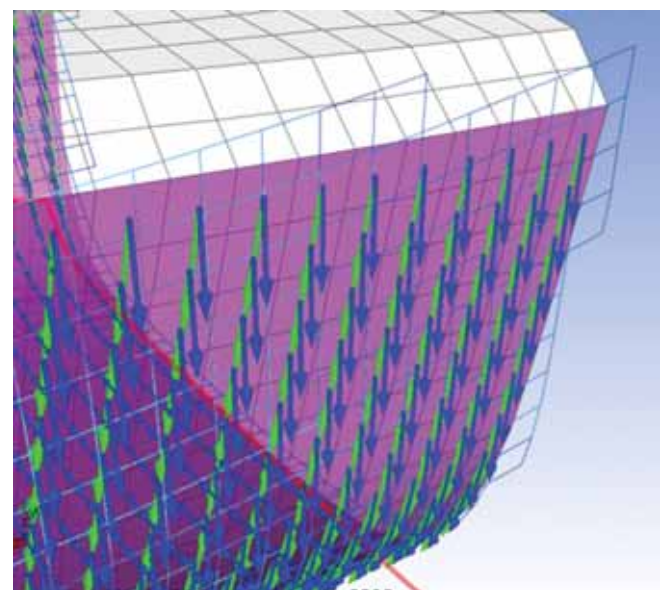
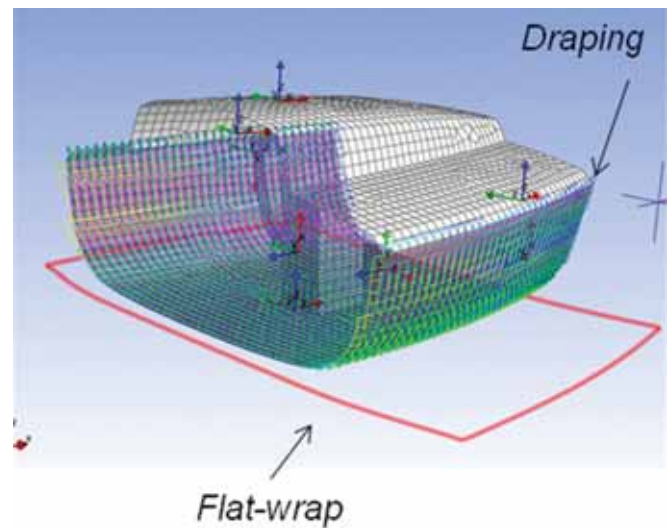
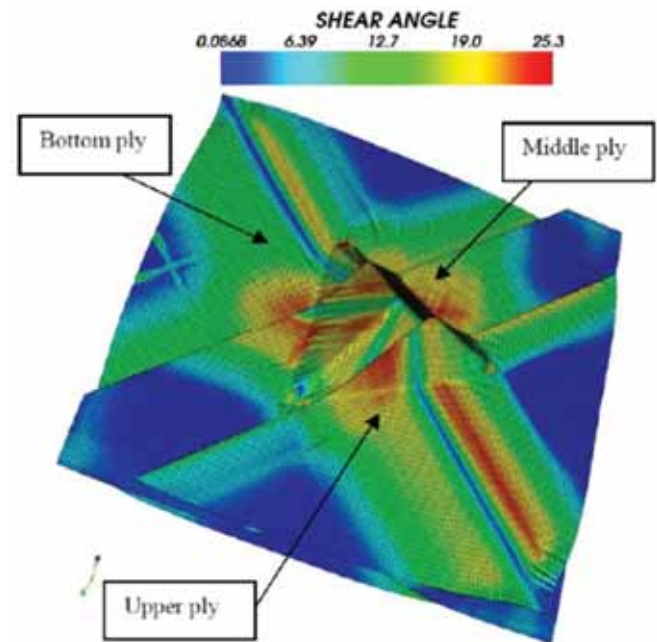
Dedicated to allow for easy and efficient definition and modification of layered-composite structures as well as their specific post-processing:



- Dedicated to provide leading-edge technology in pre- and postprocessing of layered composite structures;
- Integrates in ANSYS Workbench as well as ANSYS Classic
- Direct CAD imports from all major CAD products;
- Import of standard geometry formats (STEP, Parasolid...);
- Geometry cleaning;
- Best-in class meshing capabilities for surface and solid models – with linear or quadratic elements.

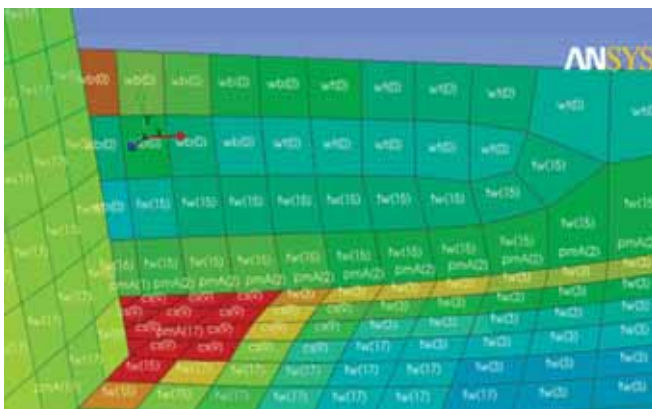
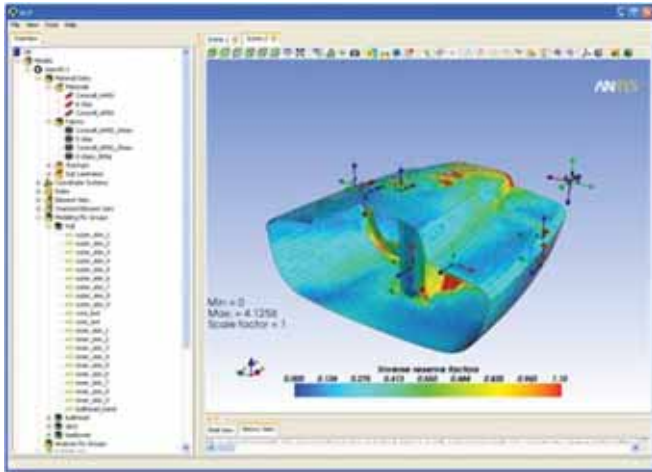
Preprocessing

Unique material definition functionality, tailored for modeling layered composite structures:



- Basic materials with engineering constants;
- Uniaxial fabrics with vendor-specific data;





- Multiaxial fabrics with vendor-specific data;
- Standard laminate templates.

Coordinate systems

- Cartesian, cylindrical, spherical.

Oriented element-set concept

- Definition of material application direction independent of shell normal;
- Definition of material 0° direction;
- Overlapping multiple oriented element sets;
- Unique possibility of easy asymmetric laminate definition;
- No need of ply subdivision.

Surface and 3-D modeling:

- Generation of layered solid composite models from layered shell models;
- Layer-wise post-processing of layered solid and layered shell models.

Draping and flat-wrap functionality:

- Analysis of draping, write and load draping dataM;
- Analysis of fiber-angle correction;
- Flat-wrap analysis and export of plies with distortion.

Postprocessing

Comprehensive composite failure analysis capabilities:

- Inverse reserve factors (IRF), reserve factors (RF) and margin of safety (MOS) for composite failure criteria at all integration points of all layers.
- Arbitrary combinations of failure criteria:
 - Max. strain, max. stress, Tsai-Wu, Tsai-Hill, Hashin, LaRC, Cuntze;
 - Puck 2-D and 3-D for UD and weave materials;
 - Core failure and face sheet wrinkling for sandwich structures.
- Multiple load case consideration:
 - 4 result values per in-plane data point;
 - Maximum IRF of all criteria of all layers;
 - Active failure mode;
 - Layer index with highest IRF;
 - Critical load case.
- Simple definition, configuration and combination of desired composite failure criteria;
- Unique method to evaluate interlaminar normal 3-D stress in curved laminates based on shell elements;
- Element sampling enables ply-based strain, stress and IRF visualization;
- Result visualization for each ply of the laminate;
- Text plot highlights critical failure mode, layers and load case;
- Sensors for the evaluation of material quantity and cost;
- Python® scripting interface (e.g., for user-specific failure criteria).

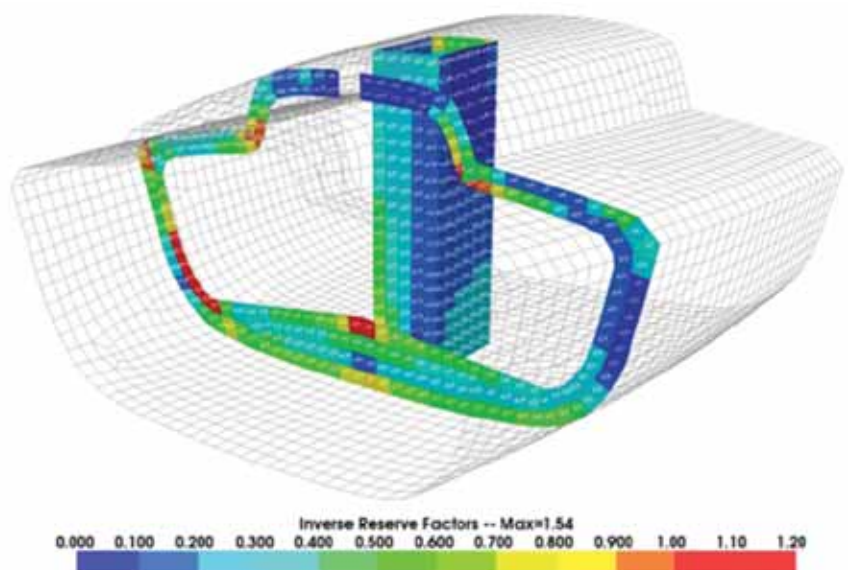
Ply-book generation

- Generation of individually formatted ply books in restructured text-format;
- Ply books can be exported in various formats (*.html, *.pdf, *.odt, etc.).

Scripting and automation

- Python scripting interface to automate model definition.

For more information:
 Marco Perillo - EnginSoft
 info@enginsoft.it



READY TO GO GREEN?



International modeFRONTIER® Users' Meeting 2010

goes green... 'cause optimize means saving: time, resources, energy.
And you? Are you ready to go green?

27th- 28th May 2010 - Savoia Excelsior Palace - Trieste - Italy

To stay competitive and gain market share, companies are forced to continuously improve the quality of the products. While this has been a longtime-held belief for most managers, only in recent years has it become clear that achieving higher quality is not necessarily at odds with efforts to reduce cost and time-to-market.

By attending the conference you will get a chance to learn how **modeFRONTIER®**, the leading multidisciplinary & multi-objective design optimization tool, is used globally by designers and managers in many industries to better understand their product development process, and achieve higher quality at reduced cost, allowing them to meet the challenge of producing better products faster.

Conference Venue

Starhotel Savoia Excelsior Palace
Riva del Mandracchio, 4 - Trieste

In the heart of the city, overlooking the fabulous Gulf of Trieste, the hotel, constructed during the Austrian imperial era, has been totally renovated with an elegant blend of traditional and contemporary style. The aesthetically appealing choices of the furnishings and details evoke the warm and elegant Mittel-European atmosphere. The 142 rooms of the hotel Starhotels Savoia Excelsior Palace, have been created to appeal to both business clientele as well as leisure travellers

About modeFRONTIER®

Traditionally companies have taken an intuitive approach to the product design process - for example testing (either physically or virtually) a prototype, assessing the results, perhaps with respect to multiple criteria, then modifying the design in an attempt to improve overall performance. While this allows the design team to use engineering knowledge to come up with a product superior to the initial design, the labour-intensive nature of this method means that rarely can more than a handful of iterations be performed. Moreover, although the resultant design may well be an improvement on the original, it is unlikely to be truly optimized.

Deadlines - Regular registration

05/03/2010 Abstract submission
15/04/2010 Notification of acceptance
30/04/2010 Submission of the full powerpoint presentation



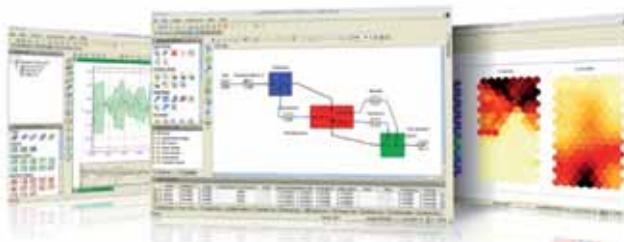
Increasingly, however, product development departments are turning to automatic mathematical search methods to drive the design process. When the entire simulation is automated (coupling different tools within the CAE environment), and powerful algorithms are applied in the exploration of the design space, allowing multiple, conflicting objectives to be balanced, significant improvements in performance can be achieved, in a fraction of the time it would take a human to perform just a few search iterations. Furthermore, the statistical insight gained (for example the importance of each design variable on the performance metrics) provides an invaluable understanding of the product.

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Online conference registration
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www.esteco.com

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ANSYS Electrostatic: il valore aggiunto del software nella complessa attività progettuale dei wafer di silicio per applicazioni sensoristiche

I wafer di silicio costituiscono elementi essenziali nell'assemblaggio dei sensori avendo essi sia funzioni di supporto meccanico sia di adeguata conducibilità elettrica; essi infatti sono posti all'interno della camera al plasma ed hanno l'obiettivo di controllare le condizioni ambientali affinché le lavorazioni sugli elementi circuitali introdotti nella camera siano ottimali.

Tuttavia essi per le condizioni ostili di lavoro costituiscono un problema di serio dimensionamento avendo l'onere di sopportare carichi termici ed elettromagnetici di elevata intensità.

In generale essi sono posti su elementi di bloccaggio (ESC: electro static chuck) ad effetto capacitivo e quindi tali da porre il circuito di misura a stress elettrostatico. Il valore aggiunto del software (ANSYS Electrostatic) consiste nel poter adeguatamente simulare e verificare le condizioni

operative dei sensori in termini di temperatura e campo elettrico, ed eventualmente progettare la efficace funzionalità disponendo adeguatamente di pin di indio atti a mitigare il valore locale del campo elettrico: infatti con la presenza dei pin si introduce una sorta di gabbia di Faraday ed il problema è che, data la specificità del problema, non sono note a priori né il numero né la dislocazione ottimali degli stessi pin di indio.

L'uso della simulazione è in tal caso di evidente utilità e le analisi qui di seguito esposte mostrano l'efficacia di tale metodologia progettuale.

Lo strumento utilizzato (ANSYS Electrostatic) è applicato ponendo in essere le proprie capacità di generare mesh esaedriche, condizioni necessarie al calcolo corretto dei valori di campo elettrico e termico.

Pur nelle evidenti complessità è stata volutamente trascurata la non linearità dei materiali sotto il profilo elettrostatico avendo peso minore rispetto alla differente tipologia di silicio oggetto di confronto della analisi numerica.

Altresì adeguata attenzione è stata posta alla descrizione

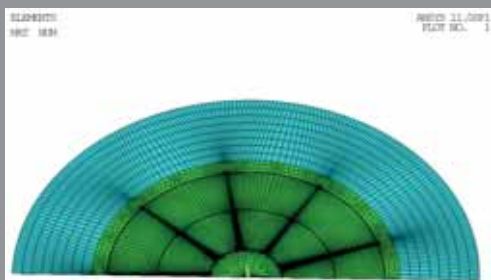


Fig. 1

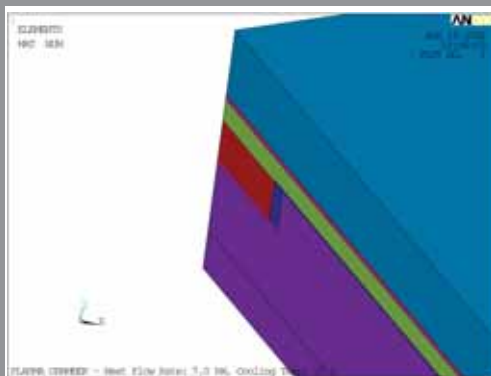


Fig. 2 - Spessori del multistrato

geometrica dell'ESC, avendo cura di rappresentare sia le scanalature che i canali caratteristici ed ovviamente il dominio di vuoto circostante il modello dell'ESC (Fig. 1).

Nello spessore del modello si è prestatto attenzione a rappresentare i singoli strati del wafer caratterizzati da materiali con proprietà elettriche diverse (Fig. 2).

Nella figura 3 sono rappresentate le piste circuitali costituenti i sensori

In ultimo, i contatti di indio sono stati rappresentati con elementi finiti di conducibilità elettrica elevata (Indio) (Fig. 4).

Il modello è stato generato in forma parametrica dando la possibilità

al software di localizzare le posizioni dei pin di indio in funzione della minimizzazione del valor medio del campo elettrico; altro elemento di non facile determinazione è la non arbitrarietà della posizione dei pin che ovviamente non possono forare la parte circuitale; difatto le condizioni di input erano sensibili alla valutazione dell'efficacia dei pin di bordo e quindi in determinate configurazioni di analisi il numero di pin è cresciuto fino a 40.

Altro elemento fondamentale è il numero di incognite 600000 che sono sintesi di puntualità nell'ottenimento del risultato e di capacitàolutiva hardware.

In conclusione, le diverse configurazioni in esame a valle delle numerose analisi hanno dato la possibilità al progettista di scegliere confidenzialmente la soluzione ottimale evitando un laborioso ed estenuante lavoro di prove e verifiche sperimentali (Fig. 5).

Per maggiori informazioni:

Emiliano D'Alessandro - info@enginsoft.it



Third Wave Systems AdvantEdge™ FEM version 5.5 Release Announcement

EnginSoft is pleased to announce the release of Third Wave Systems AdvantEdge FEM version 5.5. AdvantEdge FEM is a materials-based software solution for the optimization of metal cutting, and has been an innovative computer aided engineering (CAE) software package since its inception. The finite element analysis software provides detailed information about heat flow, temperatures, stresses, and forces for machining processes.

Included in version 5.5 are new tool and workpiece materials, as well as a variety of valuable enhancements to existing features. In addition to more than 50 GUI improvements to improve the user experience, there have been several improvements to the engine and meshing capability. Also improved is the meshing logic used, so certain changes to the setup that previously required remeshing the tool and workpiece, can now run without any additional remeshing. This should make project setups faster and easier for our users, especially those with complex project setups.

Among AdvantEdge FEM's standard features are:

- STEP, STL, VRML, and DXF tool import
- Standard and custom tool creation
- Library of 130+ workpiece materials
- User-defined material and constitutive models
- Residual stress modelling
- Temperature and stress analysis of the following processes:
 - Milling (2D and 3D)
 - Turning (2D and 3D)
 - Drilling (3D)
 - Boring (3D)
 - Tapping (3D)
 - Grooving (3D)
 - Broaching (2D)
 - Sawing (2D)

Ongoing software benefits experienced by AdvantEdge FEM users are:

- Increased material removal rates
- Improved tool life
- Predicted chip shape
- Shortened product design cycles
- Reduced trial and error testing

Ing. Enrico Borsetto - EnginSoft
info@enginsoft.it

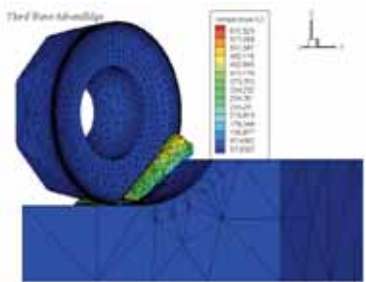


Fig. 3

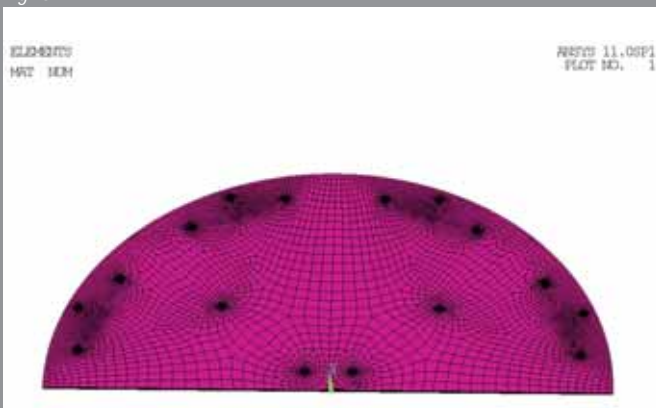


Fig. 4

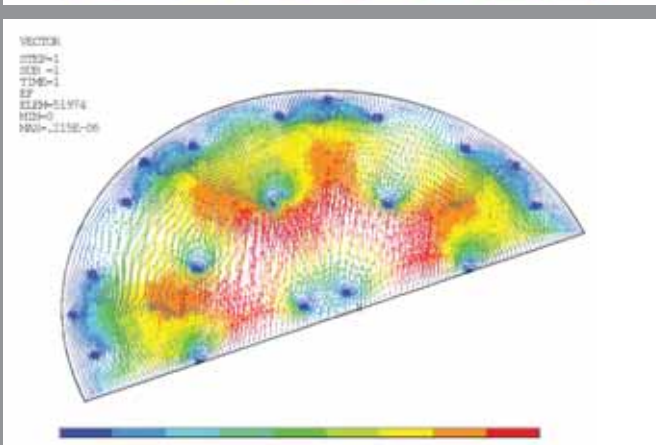
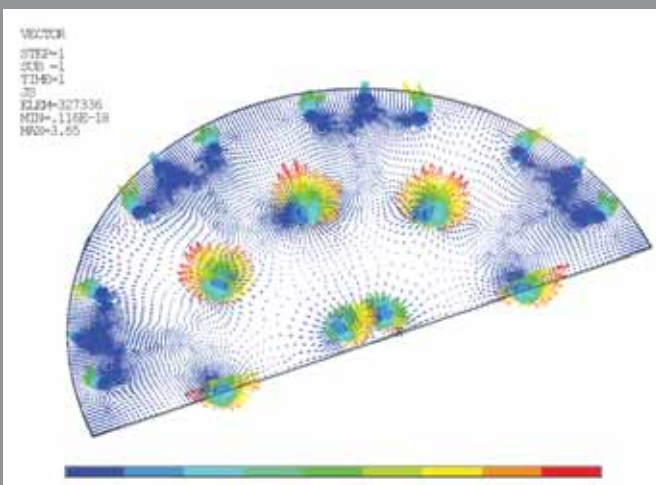


Fig. 5



Third Wave Systems AdvantEdge™ Production Module 5.7 Release Announcement

EnginSoft is pleased to announce the release of an updated version of Third Wave Systems NC program optimization software, AdvantEdge Production Module 5.7. Production Module is process-analysis CAE software that integrates workpiece material properties, CAD/CAM inputs, and machine dynamics to map forces, temperatures, and more. Over the years, this technology has become integral to engineers looking to reduce costs and cycle times, maximize machine utilization, and reduce tool breakage. By displaying results visually, Production Module allows users to better understand the machining process to avoid potential problems and identify opportunities for improvements.

Production Module 5.7 introduces many new and/or enhanced features in both its 2D and 3D editions, including:

- Improved MetalMAX stability data import (3D)
- Split line optimization - allowing for greater optimization efficiency (2D and 3D)
- Tool center programming (3D)
- VERICUT profile tool definition (3D)
- Center drilling (2D)
- Tool change time transients (3D)
- Graphing results overlay (2D)
- Subsequence optimization (2D)
- Improved APT cycle definition (3D)
- New workpiece materials (2D and 3D)

Benefits to using the software include:

- reduced cycle times
- maximized machine utilization
- improved tool life
- increased productivity

Ing. Enrico Borsetto - EnginSoft
info@enginsoft.it

Novità da Transvalor

Forge 2009 è in grado di individuare le migliori condizioni di processo per ottenere un determinato obiettivo nei limiti fissati dall'utente. Questa nuova funzione consente di impostare una configurazione di primo tentativo e quindi effettuare un'ottimizzazione automatica in grado di fornire i migliori risultati possibili, ad esempio l'assenza di ripieghe, il completo riempimento degli stampi, il minor carico pressa, ecc.

Maggiori informazioni nella sezione di Forge sul sito di EnginSoft.



modeFRONTIER highlights release 4.2.0

ESTECO is proud to announce the release of v4.2 of the multi-objective optimization and design environment software, modeFRONTIER. This state-of-the-art PIDO tool, written to allow easy coupling to almost any Computer-Aided-Engineering (CAE) tool, is now even more powerful and user-friendly than previous versions.



DOE Algorithms

Taguchi Orthogonal Arrays

The new Taguchi Orthogonal Arrays is based on the Taguchi method which allows to find the best values to make the system less sensitive to variations in uncontrollable noise factors.

New Latin-Hypercube Sampling

The new Latin-Hypercube Sampling option lets the user to import and set the desired distribution values from a given cluster ID. The import option can be extended to any Design Table ID or DOE Table ID. Local correlation values existing among the variables of the cluster selected are imported and might be additionally edited in the resulting correlation matrix.

Schedulers and Optimizers

New FMOGA-II and FSIMPLEX

New FMOGA-II and FSIMPLEX exploit an efficient internal adaptive Response Surface method. Performance of the previous version algorithms has been considerably enhanced due to the combination of adaptive RSM and optimization algorithms.

AFilterSQP

AFilterSQP is a mono-objective Sequential Quadratic Programming algorithm which obtains global convergence through a filter technique. The filter accepts new points which obtains a sufficient improvement either for the objective value or the constraints violations. This gradient-based algorithm can deal with with single-objective problems both in the constrained and in the unconstrained case and it is suited for nonlinear problems.

NBI-ASQP

NBI-ASQP is a multi-objective Sequential Quadratic Programming algorithm which applies the NBI method to any generic smooth multi-objective problem.



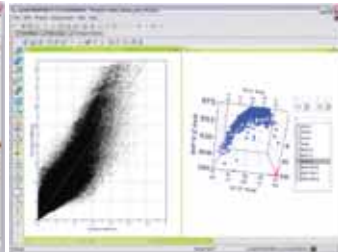
NBI-ASQP reduces the problem to many single-objective constrained subproblems (the so called "NBI subproblems"). The NBI method is coupled with the AFSPQ single-objective solver in order to get the solutions of these subproblems.

Data Mining

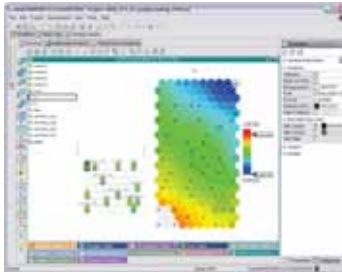
New functions have been added to the Tools and Charts available in order to make life easier for users when exploring and assessing the data available in the Design Space tables.



New Principal Components Analysis (PCA) Charts



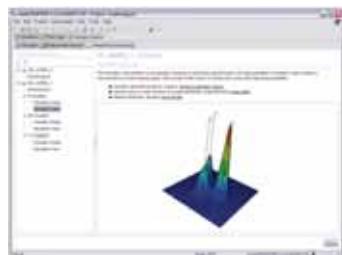
New Multi Dimensional Scaling (MDS) Charts



New Overall Student Chart



Mountain View for Clusters



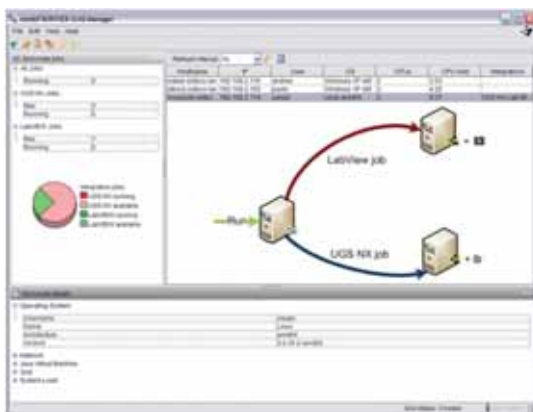
New Self-Organizing-Maps (SOM) Components Chart

Many new post-processing features have been introduced in the version 4.2 like: New Design Filter Tool, New RSM Explore Bar visualizer, New Categories Visualizers, Factor Analysis Tool, Batch Report Creator. Moreover, many of the existing charts have been considerably enhanced.

The Process Integration

Grid System

Grid System powered by GridGain system enables modeFRONTIER for grid computing. Consequently, it is possible to submit

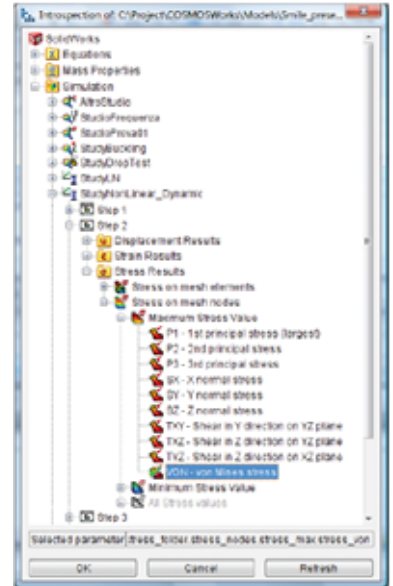


Workflow job across a local network, wait for the execution and retrieve the results.

The Grid System is available in beta version for the UGS-NX and LabVIEW nodes only.

Solidworks Simulation

New SolidWorks Direct Integration node to include SolidWorks Simulation (formerly known as COSMOSWorks). The interface enables the users to perform multi-objective optimization by handling CAD parameters as well as driving the Simulation component available in SolidWorks.



LabVIEW Direct Integration Node The LabVIEW Direct Integration Node is the interface to the National Instruments flagship product LabVIEW.

SFE Concept Node

The SFE Concept Direct Integration Node allows the SFE Concept users to handle parametric models from within modeFRONTIER. The Workflow is created automatically by parsing the SFE Concept model files.

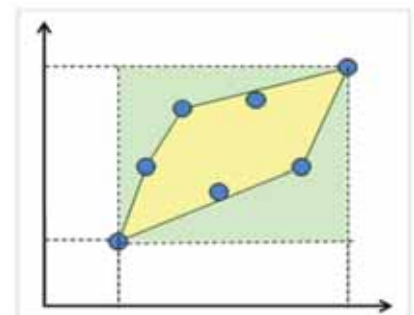
Python Node

The Python Direct Integration Node lets the user to handle scripts using custom Python interpreter as well as Custom Python modules library. This node allows easy coupling of any CAE software which can be driven in batch mode via Python, including ANSYS Workbench 12, ABAQUS/CAE, Paraview, etc.



Convex-Hull for Design Space

Convex-Hull technique is particularly useful to impose constraints on the range of input variables when the standard definition of input variables through Lower Bound and Upper Bound is not suitable to define the space of feasible solutions.



For more information: Francesco Franchini info@enginsoft.it



Tecnomare, Società d'Ingegneria che opera nell'ambito della progettazione globale di impianti di approvvigionamento idrocarburi, sceglie EnginSoft

Tecnomare, importante Società d'Ingegneria del Gruppo ENI, opera dal 1971 in un contesto internazionale nell'ambito della progettazione e dello sviluppo di servizi di ingegneria. Le attività dell'azienda coprono ogni fase del ciclo di vita degli impianti upstream, dagli studi di fattibilità ai progetti costruttivi, dallo start-up al decommissioning.

Operazioni in settori quali deep-water e subsea, progettazione & management, HSE, maintenance engineering, caratterizzano competenze d'eccellenza dell'azienda. Tecnomare sviluppa anche analisi HSEQ, servizi di certificazione, progettazione di tecnologie innovative nell'ambito Oil&Gas e fornisce attrezzature e sistemi chiavi in mano.

Nel passato, anche recente, EnginSoft ha collaborato con Tecnomare allo sviluppo di attività d'ingegneria su progetti di una certa consistenza, raccogliendo da Tecnomare stessa fiducia ed apprezzamento.

Da gennaio di quest'anno, a seguito di Gara indetta da Tecnomare, ad EnginSoft è stato assegnato un Contratto Aperto come fornitore qualificato per lo sviluppo di Servizi d'Ingegneria Strutturale nell'ambito della progettazione di:

- piattaforme fisse a pali e a gravità (jacket, pali, template, deck, moduli, fiaccole, ponti...);
- moduli per impianti su barge, FPSO, strutture galleggianti;
- strutture galleggianti navalizzate (cargo barge, FPSO, TLP...);
- terminali offshore;
- opere a terra per impianti onshore (moduli, pipe-rack, fondazioni, piping stress analysis...).

Ciò significa che EnginSoft, società italiana di maggior consistenza e tradizione nel settore della sperimentazione virtuale e del CAE, sulla base delle proprie competenze e capacità è stata ancora una volta in grado di proporsi come partner affidabile in relazione alla varietà delle problematiche afferenti all'Offshore e all'Oil&Gas, sia rispetto all'impiego di software dedicati sia riguardo allo sviluppo di soluzioni/collaborazioni su misura.

L'esperienza progettuale diretta, il raggiungimento di una massa critica di conoscenze pratiche su basi solide, l'abitudine, fatta sistema, di valorizzare l'impiego dei modelli al computer utilizzandoli solo dove, come e quando servono, consentono, pertanto, ad EnginSoft di porsi a fianco di aziende leader nel loro settore e di aumentarne, per le stesse, le capacità di successo e di conseguimento dell'eccellenza.

A completamento della presente informazione, si segnala che anche con Saipem, altra importante Azienda del Gruppo ENI, è attiva da 4 anni una Convenzione Aperta attraverso la quale, in base al tratto distintivo di EnginSoft, che è la multidisciplinarietà delle competenze nelle tecnologie specifiche, sono cresciuti rapporti di collaborazione sia nell'ambito dell'ingegneria strutturale sia nel contesto delle simulazioni termo-fluidodinamiche e di processo.

In sostanza, all'interno di EnginSoft sono maturate conoscenze tecniche d'eccellenza mirate all'elaborazione di soluzioni tecniche ottimali e si è ampliata l'attitudine ad agire attivamente in maniera integrata nei progetti che, talvolta, richiedono anche sviluppo di concetti non convenzionali.

Attualmente, all'interno di detta Collaborazione con Saipem, EnginSoft sta lavorando all'Ingegneria di Basic di componenti meccanico-strutturali per il Progetto CastorONE JLT, progetto che si riferisce al varo a J di pipeline in alto fondale mediante impiego del pipelaying vessel CastorONE.

Per maggiori informazioni:
Livio Furlan - EnginSoft
info@enginsoft.it



Tecnomare - ENI Group, Engineering Company for Oil Upstream chooses EnginSoft

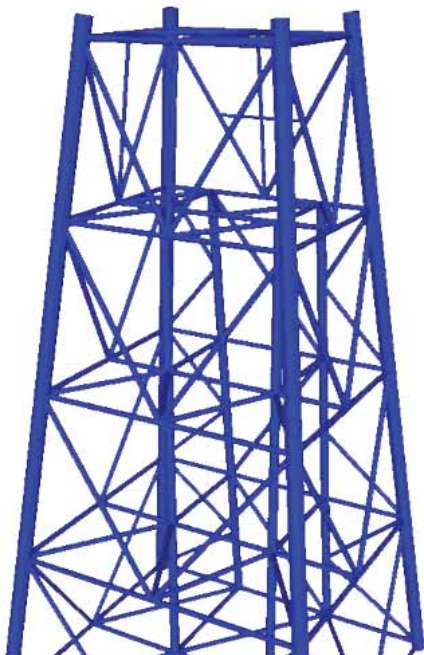
Tecnomare is a renowned engineering company of ENI Group, internationally committed to designing and developing engineering services related to upstream plants, deep water and subsea operations and, generally speaking, to innovative technologies for the Oil&Gas sector.

EnginSoft has been collaborating with Tecnomare under an "Open Agreement" as qualified supplier for the design of several structures, such as fixed and floating platforms, off-shore terminals, on-shore works and plants.

This collaboration, like many others, sees EnginSoft as a reliable and qualified partner able to provide tailor-made solutions and engineering expertise for the most diversified problems in the offshore and Oil&Gas sectors.

The fruitful and successful relationship with ENI Group includes also an open agreement with Saipem. Thanks to the multidisciplinary expertise offered by EnginSoft, the collaboration comprises structural engineering applications, thermal fluid-dynamic and process simulations.

Currently, EnginSoft is involved in the Castor ONE JLT Project, for the J laying of a deep water pipeline.



Hy.per.CAE: nuova Joint Venture tra EnginSoft e Cineca

Bologna 8 marzo 2010

È stata costituita oggi, presso il Cineca a Casalecchio di Reno (BO), una "Joint Venture Contrattuale" tra la società EnginSoft S.p.A. ed il Cineca stesso, denominata Hy.per.CAE - High performance Computer Aided Engineering).

La firma all'accordo è stata apposta dal Presidente di Cineca, il Prof. Mario Rinaldi, e dall'Amministratore Unico di EnginSoft, l'Ing. Stefano Odorizzi.

Hy.per.CAE nasce dalla volontà dei soci fondatori, CINECA ed EnginSoft S.p.A., di mettere a fattor comune le rispettive competenze, tecnologie software e di supercalcolo per proporre al mondo industriale un'offerta di servizi di calcolo tecnico senza eguali nel panorama italiano ed europeo. La costituzione della Joint Venture rappresenta il primo passo formale verso la successiva costituzione di una newCO che porterà lo stesso nome.

CINECA, Consorzio Interuniversitario ed Ente privato senza fini di lucro, è il più importante centro di supercalcolo in Italia e uno dei più avanzati in Europa. www.cineca.it

Hy.per.CAE si è data come mission principale quella di supportare le aziende industriali nelle fasi di progettazione ed ingegnerizzazione dei loro prodotti attraverso un uso combinato, competente e professionale delle tecnologie CAE, di Ottimizzazione Multi-Obiettivo e dei supercalcolatori.

Principali settori di riferimento:

1. energetico
2. meccanico/meccatronico.

Le attività operative per sviluppo dell'accordo hanno inizio con decorrenza immediata.

Per informazioni: info@enginsoft.it



Prof. Mario Rinaldi, President of Cineca, and Stefano Odorizzi, CEO of EnginSoft, signing an agreement for High Performance CAE

Il progetto newFRONTIER: gli obiettivi e le attività svolte

La Sperimentazione Virtuale come strumento di progettazione collaborativa per l'integrazione e la valorizzazione del know-how aziendale



Il 16 dicembre 2009 ha avuto luogo, presso la sede di Trento di EnginSoft, la presentazione dei risultati finali del progetto newFRONTIER (co-finanziato dalla Provincia Autonoma di Trento), che, a partire dal 2006, di pari passo con il procedere delle attività, ha visto il coinvolgimento di un numero via via crescente di tecnici e ricercatori, nonché la collaborazione di Università, Centri di Ricerca ed imprese all'avanguardia nell'utilizzo delle metodologie e degli strumenti di sperimentazione virtuale.

La presentazione, svoltasi alla presenza dei professori Vigilio Fontanari e Luca Lutterotti dell'Università degli Studi di Trento, in qualità di valutatori del progetto, è stata anche l'occasione per ripercorrere, nel dettaglio, le fasi che hanno portato dall'analisi metodologica iniziale, allo studio degli aspetti connessi con tematiche di tipo IT e di integrazione software, sino al momento conclusivo, avente valenza di verifica della validità del lavoro svolto, consistente nell'implementazione, in diversi ambiti industriali, di progetti pilota dedicati.

Il contesto

La diffusione delle tecnologie di sperimentazione virtuale nelle imprese è tipicamente caratterizzata da una modalità di utilizzo per comparti indipendenti. Questo implica, molte volte, come conseguenza, la marginalizzazione di alcuni ruoli e persino un'errata percezione dell'utilità stessa delle tecnologie implementate, legata in parte al fatto che la loro efficacia può essere apprezzata soprattutto nel medio periodo, talvolta a prezzo di una reingegnerizzazione dei processi progettuali.

La complessità del quadro aumenta ulteriormente se si considera la specificità che tali aspetti assumono nelle PMI che, rispetto alle grandi industrie, possono risentire di ulteriori limitazioni, per quanto riguarda, ad esempio, l'accesso a banche dati, procedure e metodi avanzati di analisi.

Non va infine sottaciuto il fatto che, dal lato tecnico, si ri-

sente talvolta di una inadeguata percezione di problematiche di tipo tecnico – economico – strategico di portata più ampia.

L'approccio di EnginSoft

EnginSoft, come è noto, si occupa di Computer Aided Engineering, nell'accezione più vasta data a questo termine, già dagli anni '80, anni decisamente pionieristici in questo settore. Anche grazie all'esperienza maturata, tratto caratteristico dell'azienda – ed unico nell'attuale panorama italiano dei fornitori di servizi CAE – è oggi proprio la capacità di legare metodologie ed applicazioni in una logica di "design chain", valorizzando la sperimentazione virtuale nell'intero ciclo di progettazione e produzione, a sostegno di scelte e decisioni industriali coerenti.

La prospettiva generale del progetto newFRONTIER, in linea con questa visione, è stata quella di favorire la rimozione delle barriere culturali ed organizzative che ancora limitano la diffusione delle tecnologie CAE, promuovendone l'integrazione e sviluppando tecniche e procedure adeguate agli obiettivi delle diverse realtà aziendali. Si è trattato dunque di un approccio fortemente innovativo, pensato per consentire l'implementazione dei canoni dell'ingegneria collaborativa nei processi progettuali e produttivi e capace di far emergere e di valorizzare la "core knowledge" aziendale: entrambi questi aspetti sono indicati come prioritari anche dai programmi di ricerca della Comunità Europea, in quanto strategici per incrementare la competitività dell'industria europea nel mercato globale, in conformità con quanto esplicitamente previsto tra l'altro dalla "Strategia di Lisbona".

Le attività di ricerca

L'idea fondamentale dalla quale il progetto ha preso le mosse è stata quella di ampliare ed approfondire gli elementi di differenziazione e innovazione che caratterizzano l'approccio su cui si basa il software modeFRONTIER.

Nello specifico, tra le tematiche affrontate, le principali hanno riguardato:

- il trattamento delle incertezze, secondo le categorie comuni nei contesti progettuali (dal "robust design", alla "reliability analysis", alle tecniche di tipo "Design For Six Sigma");



- la creazione di modalità innovative di formalizzazione logica, che consentissero la gestione flessibile di problemi di qualunque complessità;
- l'analisi e l'implementazione di nuove famiglie di algoritmi, dedicati all'individuazione delle configurazioni progettuali di ottimo e, più in generale, al supporto delle decisioni;
- l'integrazione software, per comunicazione diretta bidirezionale, da affrontare sulla base di valutazioni di tipo sia tecnico, sia strategico.

Fondamentale infine, nell'ambito del progetto, è stata la fase di verifica, in contesti applicativi concreti, dei principali aspetti innovativi esplorati, per quanto riguarda metodi, algoritmi e protocolli di integrazione.

A tale scopo sono state messe in atto una serie di collaborazioni con importanti realtà industriali insieme alle quali stati sviluppati progetti pilota in quattro diversi ambiti:

- progettazione di elettrodomestici (settore del bianco);
- processi industriali (saldatura di materiali a base polimerica);
- sistemi di controllo (sensoristica applicata a sistemi HVAC);
- progettazione di grandi opere (ingegneria civile).

Al termine del progetto, il confronto effettuato tra gli obiettivi iniziali e le attività portate a termine ha consentito di verificare che tutti i risultati ottenuti sono stati non soltanto pienamente conformi alle attese, ma, in più di un caso, essi hanno addirittura superato le previsioni.

Oltre ai vantaggi derivanti dall'insieme delle attività di ricerca condotte, che costituiranno un punto di partenza imprescindibile per la successiva industrializzazione di applicazioni specifiche, vanno ricordate anche le relazioni istituite con i produttori di tecnologie software (in almeno due casi verranno a breve sottoscritti accordi per lo sviluppo di applicazioni "embedded"/verticalizzate).

Merita poi di essere opportunamente evidenziato il fatto che il progetto newFRONTIER ha costituito per EnginSoft un'eccezionale esperienza di gruppo, nel corso della quale si è assistito ad un sensibile incremento del livello di integrazione tra le diverse aree tecniche che compongono l'azienda e, fattore notevole, soprattutto se si considera la situazione economica contingente, ad un aumento del numero dei ricercatori che compongono lo staff tecnico della sede di Trento.

Come ogni progetto di ricerca, infine, anche il progetto newFRONTIER ha consentito non solo di fare importanti passi in avanti nella direzione dell'incremento della conoscenza in diversi ambiti, alcuni dei quali già promettono di portare ad importanti evoluzioni delle metodologie progettuali disponibili, ma ha evidenziato anche l'esistenza di nuovi e promettenti campi di indagine nei quali, allo stato attuale, la tecnologia si trova a fare i primi passi.

Contatto per ulteriori informazioni:

Ing. Angelo Messina – R&D Manager - info@enginsoft.it

Ing. Diego Trabucco – R&D

Scheda: le collaborazioni

L'esperienza di EnginSoft nella partecipazione a progetti di ricerca finanziati sia dalla Comunità Europea, sia da enti e agenzie nazionali è ormai consolidata, e, anche in qualità di laboratorio riconosciuto dal MIUR per il trasferimento di tecnologia all'industria, ha partecipato ad un grande numero di attività di ricerca promosse da aziende terze. La ricerca è quindi, in EnginSoft, un'abitudine consolidata (l'intero staff tecnico è costituito da laureati o PhD nei settori dell'ingegneria, dell'informatica, della matematica e della fisica), così come lo è lo sviluppo di attività in team allargati e multi-nazionali.

Sulla scia di questa consuetudine, dimostratasi estremamente efficace e proficua in numerose attività pregresse, anche nel corso del progetto newFRONTIER ci si è avvalsi di importanti collaborazioni esterne, in ambito nazionale ed internazionale, tra le quali si possono ricordare quelle allacciate con:

- il **Laboratorio di Ingegneria della Conoscenza dell'Università di Milano-Bicocca (Dipartimento di Informatica, Sistemistica e Comunicazione)**, che ha contribuito al progetto in relazione a tematiche di rappresentazione e gestione della conoscenza;
- il **Dipartimento di Meccanica e Tecnologie Industriali dell'Università di Firenze e l'Accademia Italiana del Sei Sigma**, che hanno collaborato nelle fasi di definizione dello stato dell'arte relativo alle metodologie ed agli strumenti più utilizzati in ambito Design For Six Sigma, nonché nella messa a punto di linee guida di implementazione di strumenti basati su metodologie di tipo "House of Quality", "Failure Mode and Effects Analysis" e "SIPOC Diagram";
- la società **Dynardo GmbH** (impresa dedicata allo sviluppo di software ed alla consulenza, nata da un'alleanza tra **CADFEM GmbH (D)** e **l'Università Bauhaus di Weimar**), con la quale è stata condotta una collaborazione scientifica mirata alla valutazione di funzionalità avanzate (soprattutto relativamente alle analisi di affidabilità), nell'ottica di una possibile loro integrazione in modeFRONTIER;
- la società **Inutech GmbH** (Innovative Numerical Technologies), della cui consulenza ci si è avvantaggiati nello sviluppo di algoritmi in grado di risolvere problemi di ottimizzazione in cui compaiano contemporaneamente variabili discrete e variabili continue;
- la società **SimNumerica Srl**, che ha ideato e sta industrializzando il software μ Lab (Micro-controlled Systems Simulation Laboratory), orientato alla progettazione virtuale ed alla verifica di sistemi fisici governati da microprocessori / microcontrollori / DSP e ideato per integrare modelli che provengono da strumenti CAE di vario tipo.



2008 Third Wave Systems Award conferred on EnginSoft

EnginSoft attended to the 2009 Third Wave Systems AdvantEdge International Users' Conference held in Fort Worth, Texas (USA) on May 13 and 14. This annual event, which is geared specifically toward AdvantEdge machining simulation software users, welcomed more than 50 attendees from across the globe, including Canada, Sweden, Italy, USA, Turkey, and Germany.

With expert presentations from the world's industry and academic leaders, and new software feature training sessions for both AdvantEdge FEM and AdvantEdge Production Module, the 2009 AdvantEdge Users Conference was showcasing software applications and best practices that helped companies reach productivity objectives.



Kerry Marusich, TWS President, gives 2008 TWS Distributor of the Year award to Giorgio Buccilli, COO EnginSoft. From the left: Luis Zamorano, sales manager, TWS; Kerry J. Marusich, president, TWS; Giorgio Buccilli, COO, ES; Enrico Borsetto, machining technical manager, ES; Troy D. Marusich, CTO, TWS.

EnginSoft presented a new integration between AdvantEdge FEM and modeFRONTIER, the multi-objective optimization software, which allows an automated optimization procedure of process parameters and tool geometry. This link also allows a more consistent and efficient use of the software AdvantEdge FEM, extending its potentials.

Also, EnginSoft was awarded 2008 TWS Distributor of the Year Award. The annual award is given in person each year at the International Users Conference to the distributor with the largest percentage of growth over the previous year.

For further information on Third Wave Systems AdvantEdge, please contact:
Ing. Enrico Borsetto - EnginSoft
info@enginsoft.it

Baraldi Motultech ed Enginsoft hanno siglato un accordo di collaborazione tecnologica.

Bologna 11 Gennaio 2010 - Baraldi Motultech, marchio di riferimento della progettazione e produzione di distaccanti per la pressocolata delle leghe leggere ed Enginsoft, società italiana di maggior consistenza e tradizione nel settore della sperimentazione virtuale e del CAE, hanno siglato un accordo di collaborazione tecnica finalizzato all'integrazione e sviluppo delle proprie tecnologie.



Il ciclo di lubrificazione nella pressocolata rappresenta oggi la frontiera tecnologica a più alto contenuto di sviluppo potenziale e, per questo motivo, le due Società hanno deciso di condividere know-how ed esperienze.

Da una parte la chimica applicata con sistemi innovativi di controllo e gestione come Smart Lubrication System, dall'altra software di simulazione fluidodinamica, termica e strutturale, come MAGMAsoft e ANSYS, e di ottimizzazione dei parametri di processo come modeFRONTIER, rappresenteranno una base innovativa per risolvere le problematiche e le applicazioni tecnologicamente sempre più complesse che i processi di fonderia oggi richiedono.

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Baraldi Motultech

Baraldi-MotulTech è il risultato di una collaborazione nata nel 2006 tra Baraldi lubrificanti, fondata nel 1917, e il gruppo Motul, fondato nel 1853. Baraldi, che dal 1970 si occupa di produzione e vendita di lubrificanti speciali con particolare attenzione al settore pressocolata e estrusione, si è quindi unita a MotulTech, divisione del gruppo Motul specializzata nel settore dei lubrificanti tecnici per il metalworking, heat treatment, detergenza e lubrificanti speciali studiati per condizioni estreme. Oggi l'unione delle due realtà ha dato luogo ad una organizzazione in grado di operare a livello internazionale e di rispondere rapidamente e con efficacia alle sfide di mercati sempre più competitivi.

Per informazioni: www.baraldi.com

Smart Lubrication System è un marchio registrato di Baraldi Motultech.



Bifrangi: Specialisti nello stampaggio a caldo dell'acciaio

La storia della Bifrangi ha il suo inizio nell'800 a Mussolente, paese della Pedemontana, con la famiglia Biasion, tuttora proprietaria dell'azienda. Bifrangi si è sempre occupata di lavorazione a caldo dell'acciaio, inizialmente con i metodi classici del fabbro forgiatore: l'incudine, il maglio e la mola sono stati gli unici attrezzi utilizzati fin quasi alla metà del '900, con una produzione artigianale che comprendeva attrezzi agricoli e utensileria per muratori, carpentieri e falegnami.

Dopo la II Guerra Mondiale, con le prime presse, inizia la trasformazione industriale della Bifrangi, che nei successivi 50 anni avrà uno sviluppo costante che la porterà ad essere leader mondiale nella produzione di flange, ingranaggi, mozzi ed altri particolari per l'industria dell'automobile, macchine agricole, ...etc.

La necessità di diversificare la produzione ha portato la Bifrangi ad investire in Inghilterra, dove vengono prodotti flange, mozzi ed alberi motore di notevoli dimensioni per applicazioni nel campo navale ed energetico.

La Bifrangi conta circa 380 dipendenti, la maggior parte dei quali sono tecnici specializzati.

Lo sforzo costante nel razionalizzare il processo lavorativo ed integrare il più possibile professionalità e specializzazioni delle maestranze consente di effettuare internamente anche la progettazione e la realizzazione delle macchine: è stato brevettato un nuovo sistema di taglio a caldo che consente un notevole risparmio energetico, risolvendo al contempo tutti i problemi ecologici tipici di questi impianti. La qualità è il punto di arrivo di ogni produzione Bifrangi: il rispetto delle regole imposte dagli enti di omologazione viene certificato grazie a laboratori di analisi interni, che consentono di compiere prove di resistenza meccanica, trazione, controllo del grano e dei componenti chimici delle leghe.

L'elevata quantità di pezzi prodotti e la qualità richiesta, impongono un gran numero di macchinari con altissime prestazioni. In ogni settore la Bifrangi possiede quanto di meglio offerto dalla tecnologia odierna: presse da 1600 a 6500 ton, accoppiate con forni di riscaldamento ad induzione e taglio a caldo, ma anche impianti automatici "Hatebur" e "National", che permettono produzioni ad elevata velocità di pezzi da 0,3 a 4,5 Kg con altissimi standard qualitativi. A completare il quadro, internamente si effettuano anche operazioni di sabbiatura, trattamenti termici, verniciatura e le più complesse lavorazioni di finitura con centri di

con una gamma di circa 2000 articoli di peso compreso tra 0,3 Kg a 150 Kg, principalmente per il mercato Tedesco e Americano. Maggiori informazioni sul sito: www.bifrangi.it

Utilizzo di FORGE

La conoscenza dei processi per deformazione a caldo e la loro diretta applicazione nella produzione, richiede un bagaglio di conoscenze che il più delle volte rimane propria in colui che ha potuto sperimentare direttamente una determinata esperienza.

Inoltre le motivazioni del perché avvengono certi fenomeni, possono essere frutto di interpretazioni spesso fuorvianti.

La scelta di Forge è scaturita dalla necessità di garantire un maggior controllo e verifica del processo: grazie al simulatore si riesce infatti a conoscere dettagliatamente la deformazione a caldo del materiale, prevenendo difetti e mancanze di riempimento e salvaguardando le presse.

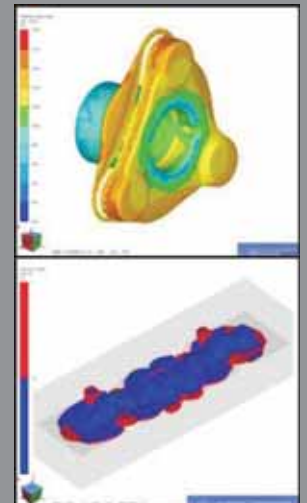
"Il ruolo di Enginsoft è stato fondamentale inizialmente per guidarci nell'utilizzo dello strumento, mentre oggi il supporto professionale fornito ci aiuta ad implementare le analisi più complesse, con molti stampi la cui cinematica è guidata dall'azione di molle" dichiara il responsabile tecnico dell'azienda.

Attualmente l'utilizzo del software Forge in azienda avviene in modo sistematico, poiché permette una "prima industrializzazione" del prodotto, nella quale si definiscono da un lato le caratteristiche geometriche degli stampi e dall'altro l'entità dei carichi richiesti dalla macchina per la deformazione vera e propria.

Tutti i risultati ottenuti dal confronto tra le prove virtuali e quelle dirette in macchina, passano allo studio di una "seconda industrializzazione" del prodotto, dove è possibile ottimizzare il dimensionamento delle attrezzature di stampaggio nonché analizzare le condizioni possibili di minimo sfrido.

Questa sequenza di operazioni permette di abbattere sensibilmente i tempi di realizzo degli stampi riducendo allo stesso tempo possibili rischi di insuccesso.

Oltre ad un utilizzo prettamente produttivo, il software viene regolarmente utilizzato per lo studio di altre casistiche connesse allo stampaggio. È il caso ad esempio del sistema di taglio a caldo delle barre, sistemi di estrazione pezzo, cinematica degli stampi, raffreddamento, coniatore a freddo, ecc.



lavoro e torni a CNC.

La produzione è di circa 60.000 tonnellate annue di pezzi in acciaio,



METEF 2010 Expo internazionale alluminio e fonderia

EnginSoft sarà presente con uno stand (Pad.5 - Stand A15) per esporre i prodotti legati alla simulazione di processo quali: MAGMA, Forge, Coldform, AdvantEdge...



Centro Fiera del Garda – Brescia (Montichiari)
14-17 Aprile 2010

Il meglio dell'innovazione tecnologica dell'intera filiera dell'alluminio e dei metalli: materie prime, macchine, impianti, attrezzature, prodotti, applicazioni estrusione – pressocolata – fonderia – laminazione – finitura – lavorazioni meccaniche – saldatura – riciclo

www.metef.com

**Durante METEF2010 EnginSoft interverrà
in due importanti convegni**

Progetto NADIA

16 aprile 2010 • Ore 11.00 - 13.00 • Sala Aida

Leghe leggere per l'automotive: le sfide del Progetto NADIA

Questo Seminario si pone l'obiettivo di illustrare alcuni dei più significativi risultati del Progetto di Ricerca NADIA (New Automotive components Designed for and manufactured by Intelligent processing of light Alloys, Contract n. 026563-2). NADIA è un progetto finanziato dall'Unione Europea per un ammontare di 7.2 milioni di Euro, che ha coinvolto, nel periodo 2006-2010 26 partners industriali ed universitari. NADIA è stato finalizzato alla valutazione del potenziale, nell'ambito dell'industria europea dei trasporti, delle leghe leggere per la realizzazione di componenti automotive basati sull'utilizzo di nano- e micro-tecnologie. È ovviamente difficile sintetizzare in un Seminario un articolato progetto durato quattro anni. Comunque, i partners di NADIA hanno il piacere di invitare quanti, sia dal punto di vista industriale che da quello accademico, si interessano alle leghe leggere, per offrire una panoramica dei risultati scientifici del progetto e della loro implementazione nella progettazione e nella produzione di componenti automotive.



Difettologia dei pressocolati

16 aprile 2010 • Ore 9.00 - 11.00 • Sala Aida

Presentazione del nuovo "Manuale di difettologia" organizzato da AIM – Associazione Italiana di Metallurgia, Centro Studi Pressocolata.

La qualità dei getti, nel settore della pressocolata, è, al tempo stesso, un argomento di essenziale attualità e di notevole criticità. È ben noto infatti che il processo di pressocolata, nell'ambito delle tecnologie di fonderia, è quello che più degli altri deve riuscire a "convivere" con la presenza di difetti, anomalie e imperfezioni nel prodotto finale, anche quando ai getti pressocolati, realizzati in serie molto numerose, sono richieste prestazioni importanti.

I difetti e le imperfezioni sopra menzionate non possono essere completamente eliminati; è però possibile, unendo competenze scientifiche, esperienze operative e potenzialità della simulazione numerica di processo:

- elaborare una classificazione sistematica e operativa dei difetti, individuarne le caratteristiche morfologiche più significative,
- descriverne le principali cause,
- mettere in evidenza i più efficaci interventi correttivi.

Tutto ciò è presentato nel "Manuale della difettologia dei getti pressocolati" realizzato nell'ambito del Centro di Studio Pressocolata dell'Associazione Italiana di Metallurgia. Il lavoro offre, con ricchezza di documentazione, uno strumento essenziale alle fonderie di pressocolata per intervenire efficacemente nel miglioramento del processo e del prodotto. La classificazione (tipologica, morfologica, delle cause, della possibilità di prevedere la presenza di difetti in vista della ottimizzazione del processo) fornita in questo documento vuole aiutare la fonderia di pressocolata ad affrontare con sempre maggior sicurezza e competenza le tematiche difettologiche, a garanzia di qualità ed affidabilità del prodotto.

Maggiori informazioni:

<http://www.enginsoft.it/eventi/2010/metef.html>



Collaboration agreement signed between Aperio Technology and UPM-MotoStudent

On 10th December 2009, at the School of Industrial Engineering-EUITI Madrid, a collaboration agreement was signed between Dr. Gino Duffett, Director of Aperio Technology, and Professor Manuel Merino Egea, the Coordinator of the UPM-MotoStudent team, one of 22 teams competing in MotoStudent, an exciting competition promoted by the Moto Engineering Foundation (MEF). modeFRONTIER will play an important role with the team's young engineers, who will be able to put into practice the software knowledge acquired during the training course held at the EUITI, helping them in the process of:

- Rapidly assessing the feasibility and benefits of new ideas and identifying solutions;
- Reducing direct experimentation thereby effectively facilitating creativity;
- Exploring knowledge-based solutions oriented at obtaining real optimizations, rather than simply making compromises;
- Accelerating the knowledge transfer process, integrating suppliers into the design process effectively and comprehensively, making products more reliable, in less time and at lower cost.

Under the partnership agreement, the modeFRONTIER logo will appear on the motorcycle, posters, t-shirts and within the corporate identity of the team. AperioTec provided the software and the modeFRONTIER training course for all the team members, for its use in several different processes within the motorcycle design.



The UPM-MotoStudent team



www.upm-motostudent.com

MotoStudent

The competition sponsored by the foundation MotoStudent Moto Engineering Foundation is a challenge between university teams from Spain, Europe and the rest of the world. The objective is to design and develop a small cylinder 125cc 2t prototype race bike, which will be assessed at meetings that will be held initially at Motor City in Aragon (Ciudad del Motor de Aragon).

For the purposes of this competition, the university team should be considered as being integrated within a motorcycle racing manufacturer, to develop and manufacture the prototype under given technical and economic constraints. The competition itself is a student challenge and, over a period of three semesters, they must demonstrate and test their creativity, innovation capacity and their ability to directly apply their skills as engineers while competing with other international university teams. At the final meeting, to be held in September 2010, at Aragon Motorland Alcañiz (Teruel), the motorcycle prototypes will undergo static and dynamic tests and assessments similar to those carried out at the ITV regarding safety, gas emissions and braking. Finally, there will be a comparative test and they will compete in a circuit race with test pilots.

For more information, please visit:

www.motostudent.com



Supporters of MotoStudent



Introducing CDAJ – The modeFRONTIER distributor in Japan



CD-adapco JAPAN Co.,LTD. (later and today: CDAJ) is one of the most powerful and integrated CAE/CFD solution companies in Japan providing sophisticated engineering solutions based on CAD/CAE/CFD technologies to broad industries. CDAJ's core business consists of the three main categories of software distribution and development, engineering and consulting services, as well as system integration ranging from CAD, CFD and FEA to Optimization.

Message from Mr Chingzou Hsu, President:
In CDAJ's 15 years history, more than 600 commercial companies became our customers using the variety of CAD/CAE/CFD solutions that we are providing and constantly support. There have been many success stories, especially in the automotive, power generation, electronics, home appliances and heavy industries.



CDAJ modeFRONTIER Conference Day gathering about 200 attendees every year

In 2001, CDAJ started distribution and technical services for modeFRONTIER, the first commercial multi-objective and multi-disciplinary robust design optimization tool. Since then, modeFRONTIER has become the major solution for utilizing optimization technologies in Japan. CDAJ has been energetically working on, for example, innovative design system integration services to leverage optimization in various industrial and R&D sectors, as well as in universities.

Ever since the launch of the technology, modeFRONTIER has been very popular in the Japanese market, and it is the core software of CDAJ's optimization services and business.

CD-adapco JAPAN Co.,LTD.
Mr Chingzou Hsu, President
CDAJ Headquarter
Yokohama Landmark Tower 37F, 2-2-1-1, Minato Mirai, Nishi-ku, Yokohama, Kanagawa 220-8167, Japan
Tel. +81 45 683 1900 - URL(Japanese): <http://www.cdaj.co.jp/>

Review

1st International Roll Forming Congress

14th – 15th October 2009. Bilbao - Spain

This was the first conference ever related to this technology and organized by Labein Tecnalia. The conference was well-attended with about 120 attendees.



Aperio Technology presented a work entitled "Simulating the Complete Forming Sequence for a Roll Formed Automotive Component Using DYNAFORM." The presentation described the simulation of a complete process using roll-forming, cutting, heating and crushing of a automotive bumper and was very well received.

<http://www.labein.es/rollform/>

Computer Methods in Biomechanics and Biomedical Engineering 2010, 9th International Symposium.

24th – 27th February 2010. Valencia - Spain

The themes and topics reflect the latest developments in computer methods in biomechanics, biomedical technology and modelling of biological structures. Key objectives are to highlight and communicate new areas of future potential as well as presenting new techniques that are being successfully applied across medical technology, biomechanics and the healthcare sector.

APERIO Tecnología, together with Anybody Technology, will have an exhibition booth at the conference where both companies will jointly present the AnyBody software system for simulating the mechanics of the live human body working in concert with its environment. <http://www.cmbbe2010.cf.ac.uk/>



Shaping the Future of Manufacturing – IMS 2020 reveals research and development challenges for the manufacturing industries in the upcoming decade

How do manufacturing companies meet the challenges of global change in their industry? Following the advice of experts, for these companies it is essential to develop new manufacturing strategies based on research and innovation. The international manufacturing sector calls for a deep industrial transformation in order to meet the needed competitive, environmental and social challenges.

The project IMS2020, funded by the European Commission, picks up these challenges. It focuses on the creation of technological and foresight roadmaps towards Intelligent Manufacturing Systems (IMS) in the year 2020. The roadmaps highlight the main milestones of innovation activities (research and development, management and policy actions) needed to achieve the desired vision. "This roadmapping process is a big challenge, but also a great opportunity" says the project leader Prof. Marco Taisch, Politecnico di Milano. "It offers us the possibility to create the future of manufacturing, and to lay one cornerstone for the wealth and sustainability of our society. Therefore, we take this project very seriously."

Project Content

The roadmapping process focuses five Key Areas, which have been identified as future challenging fields. In Sustainable Manufacturing the entire lifecycle of the product and process is taken into account, paying close attention to the technology adoption to support the use and assessment of resources and materials from their design phase, through production until the end of life. Energy Efficient Manufacturing aims to reduce the use of scarce resources and the carbon footprint by considering innovative methods and technologies, as products and processes are no longer just subject to cost and quality. Key Technologies are those that yield a high impact on the next generation of manufacturing, such as model-based enterprises, nano-technology, smart materials, robotics, etc. Standardisation is critical to the successful uptake of efficient interoperable solutions in the modern globalised enterprises, and it is at the same time the essential basis for transferring research results into industrial implementation. Innovation, Competences Development and Education contains the understanding and diffusion of new learning tools such as eLearning, Technology Enhanced

Learning, Serious Games, 3D tools, etc.

Focusing on these 5 Key Areas, the project follows five objectives in total:

- Prepare a roadmap for future manufacturing research in five IMS Key Areas;
- Identify new schemes & frameworks to support manufacturing systems research;
- Stimulate small and medium enterprise's participation in international cooperative research and development projects;
- Prepare the ground for new IMS proposals and manufacturing projects;
- Establish international and inter-regional communities in the five IMS Key Areas.



Marco Taisch
IMS 2020 Project Co-ordinator

Project Vision

The IMS 2020 Vision can be summarised through three main statements. The first vision is to enable rapid and adaptive user-centred manufacturing which leads to customised and "eternal" life cycle solutions. Secondly, highly flexible and self-organising value chains have to be developed, which enable different ways of organising production systems, including infrastructures, and which reduce the time between engaging with end users and delivering a solution. Finally, sustainable manufacturing has to be promoted, due to cultural change of individuals and corporations supported by the enforcement of rules and a regulatory framework co-designed between governments, industries and societies.

Project Approach

With the help of the global industrial and academic community, the IMS2020 Roadmaps depart from the research topics and supporting actions identified in each of the five Key Areas named above. The IMS 2020 Roadmaps show the possible impacts and benefits that the implementation of research topics through international collaboration could deliver between 2011 and 2013.



The IMS2020 Roadmap is based on inputs from an online survey, industrial workshops and more than 100 interviews with industry representatives. A framework outlining the main IMS dimensions influencing all five Key Areas was designed and used to define, which snapshots to develop, according to the following figure. All features within each snapshot were then assessed on their likelihood and desirability by 2020. During a vision building workshop, inputs from each of the five KATs were gathered on how manufacturing and the world would look like in 2020, if all research topics identified within each Key Area become real. Finally, the fine granular research topics were elaborated with the help of a wiki website, where all members of the Roadmapping Support Group could log in and support shaping the most concrete ideas.

Project Community

International cooperation plays an important role for the success of the project. Only if different perspectives from different institutions from all over the world are brought together, the whole picture of research and development challenges becomes visible. Therefore, a core project team consisting of Politecnico di Milano (Italy), the Institute for Operations Management (FIR, Germany), BWI at ETH Zurich (Switzerland), the European Committee for Standardization (CEN, Europe), Comau (Italy), Clemson University (USA), Ecole Polytechnique Fédérale de Lausanne (Switzerland),

Fatronik (Spain), Institute for Prospective Technological Studies (Europe), Keio University (Japan), KAIST (Korea), CNR-ITIA (Italy), Holcim (Switzerland) and the Norwegian University of Science and Technology (Norway) was built.

But next to this wide range of international partners, another relevant group contributing to the roadmapping activities exists. The Roadmapping Support Group is a large community (more than 200) of characters and institutions from research and industry, who are interested in accompanying the roadmapping process, as well as profiting from its results. Together, the project community discovers new destinations for developing Intelligent Manufacturing Systems in the forthcoming decade. Anybody interested is allowed to join and share its knowledge.

Marco Taisch summarises "IMS2020 wants to attract interested people and organisations to have the worldwide most qualified actors in the five IMS Key Areas to discover common innovations and potential in manufacturing. Whoever wants to join us, is very welcome!"

www.ims2020.net

For more information on IMS2020, please contact:

Marco Taisch – Politecnico di Milano

IMS2020 Project Co-ordinator

Department of Management, Economics and Industrial Engineering

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EnginSoft Event Calendar

ITALY

14-15 April - Affidabilità e Tecnologie 2010
EnginSoft will present a seminar on: Co-Design e Sperimentazione Virtuale. Un Esempio Applicativo
www.affidabilita.eu

14-17 April - Metef 2010 International aluminium exhibition
EnginSoft presenting Process Simulation Technologies.
www.metef.com

7 May - Seminario Automotive. Miglioramento di prodotto con il CAE - Mirafiori Motor Village Torino
www.enginsoft.it/eventi

27-28 May - International modeFRONTIER Users' Meeting 2010. Starhotel Savoia Excelsior Palace, Trieste.
<http://um10.esteco.com/>

21-22 October 2010
EnginSoft International Conference 2010
CAE Technologies for Industry. Italy.
www.caeconference.com

CAE Webinar Virtual Tour 2010
check out the program on www.enginsoft.it/eventi

FRANCE

17-18 Mars 2010 - Micado: Etats Généraux Micado: "La contribution de l'ingénierie numérique à l'ECO conception" Evry (91) Edition exceptionnelle en partenariat avec la Chambre de Commerce de l'Essonne sur le thème: "La contribution de l'Ingénierie Numérique à l'ECO Conception"
www.af-micado.com

EnginSoft France 2010 Journées porte ouverte dans nos locaux à Paris et dans d'autres villes de France et de Belgique, en collaboration avec nos partenaires.

Prochaine événement: Journées de présentation modeFRONTIER. 2010 Séminaires Simulation de Process et Optimisation EnginSoft France Boulogne Billancourt – Paris. Seminars hosted by EnginSoft France and EnginSoft Italy
Veuillez contacter Marjorie Sexto, m.sexto@enginsoft.com, pour plus d'information ou visitez: www.enginsoft-fr.com

21-23 June – ASMDO 2010 3rd International Conference on Multidisciplinary Design Optimization and Applications - Co-sponsored by ISSMO, ESTP, EnginSoft, and NAFEMS. Paris. ASMDO 2010 will bring together scientists and practitioners working in different areas of engineering optimization!
www.asmdo.com



GERMANY

Please stay tuned to www.enginsoft-de.com, contact Stephanie Koch at: S.Koch@enginsoft.com for more information.

30-31 March 2010 - Automotive CAE Grand Challenge 2010 Congress Park Hanau. Meet EnginSoft in the exhibition and attend our presentation on Material Models of Plastics for Crash Simulation! Hear what knowledge and technologies EnginSoft offers for today's and tomorrow's automotive development! <http://www.carhs.de>

modeFRONTIER Seminars 2010
EnginSoft GmbH, Frankfurt am Main

- 30 March, 20 April, 18 May, 15 June.

Seminars Process Product Integration. EnginSoft GmbH, Frankfurt Office. How to innovate and improve your production processes! Seminars hosted by EnginSoft Germany and EnginSoft Italy.

UK

Please stay tuned to www.enginsoft-uk.com, contact Bipin Pastel at: b.patel@enginsoft.com for more information.

modeFRONTIER Workshops at Warwick Digital Lab

- 7 April 2010, 14 May, 21 June, 20 July, 12 August, 7 September, 18 October, 10 November, 7 December.

Please register for free on www.enginsoft-uk.com
modeFRONTIER Workshops with InfoWorks CS at Warwick Digital Lab

- April 2010, July 2010, October 2010.

Spring 2010 - WaPUG Spring Meeting
EnginSoft UK will be attending – www.ciwem.org/events/

20-22 April - Sustainability Live - IWEX Birmingham. EnginSoft UK will be presenting a paper on 'Advanced Techniques for Sewer Verification Modelling' at 14:10 on 20th April.
<http://www.sustainabilitylive.com/page.cfm/Link=43/t=m/goSection=19>

18 May - Pump Centre Conference. Runcorn, Cheshire
EnginSoft UK have submitted an abstract on the optimisation of pump design. www.pumpcentre.com

8-9 June - NAFEMS UK Conference. Oxford
EnginSoft UK are official sponsors of the event
www.nafems.org

SPAIN & PORTUGAL

Programa de cursos de modeFRONTIER:
APERIO Tecnología Office, Sitges/Barcelona

- 20-21 April
- 6-7 July

28 April - NAFEMS Awareness Seminar on Finite Elements and Numerical Simulation of Forming Processes. University of Aviero, Portugal

24-26 July - World Congress on Science in Athletics. Barcelona

For more information, please contact our partner APERIO Tecnología: g.duffett@aperiotec.es
www.aperiotec.es

SWEDEN

modeFRONTIER Training:
Esteco EnginSoft Nordic Office, Lund

- 8-9 April - Introduction to modeFRONTIER
- 5-6 May - Introduction to modeFRONTIER
- 7 May - Advanced topics in modeFRONTIER
- 7-8 June - Introduction to modeFRONTIER

For more information and registration, please visit <http://nordic.enginsoft.com/training/>
Contact: Adam Thorp, adam.thorp@esteconordic.se

4-5 May - Micronano System Workshop MSW 2010. Radison Blu Royal Park, Stockholm. Esteco Nordic and VTI Technologies Oy Sweden presenting: Multi-objective Optimization of a Ball Grid Array using modeFRONTIER
www.msw2010.org

EUROPE, VARIOUS LOCATIONS

modeFRONTIER Academic Training
Please note: These Courses are for Academic users only. The Courses provide Academic Specialists with the fastest route to being fully proficient and productive in the use of modeFRONTIER for their research activities. The courses combine modeFRONTIER Fundamentals and Advanced Optimization Techniques.

For more information, please contact Rita Podzuna, r.podzuna@enginsoft.it

USA

Courses on: Design Optimization with modeFRONTIER
Ozen Engineering, Sunnyvale – Silicon Valley, CA

Learn about Optimization coupled with ANSYS. OZEN can easily help you out automating the search for the optimal design. The primary audience for this course includes ANSYS Classic and Workbench users as well as new modeFRONTIER users who want to have a complete overview to all software capabilities. Stay tuned to our US partner's website for the next events in the USA:
www.ozeninc.com. info@ozeninc.com

To meet with EnginSoft at any of the above events, please contact us: info@enginsoft.com



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